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FLOOD INSURANCE STUDY

CITY OF BOSTON, MASSACHUSETTS
SUFFOLK COUNTY

REVISED:
NOVEMBER 2, 1990

Federal Emergency Management Agency

COMMUNITY NUMBER - 250286

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Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision (LOMR) process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

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FLOOD INSURANCE STUDY
CITY OF BOSTON, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Boston, Suffolk County, Massachusetts, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study represent a revision of the original analyses prepared by Harris-Toups Associates for the Federal Emergency Management Agency, under Contract No. H-4024. The work for the original study was completed in November 1979. The hydrologic and hydraulic analyses for this updated study were prepared by Dewberry & Davis for FEMA, under Contract No. EMW-85-C-2044. This work was completed in December 1987.

1.3 Coordination

On April 13, 1987, the City of Boston was notified by FEMA that an updated study would be conducted to include the effects of wave action.

On April 11, 1989, a final Consultation and Coordination Officer's (CCO) meeting was held with representatives of FEMA, the city, and Dewberry & Davis to review the results of the study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Boston, Suffolk County, Massachusetts. The area of study is shown on the Vicinity Map (Figure 1).

Tidal flooding and its wave action from Boston Harbor, Boston Inner Harbor, and Dorchester Bay was studied by detailed methods, including its effects on the Harbor Islands and the tidally affected portions of the Mystic River, the Chelsea River, and the Charles River . In addition, riverine flooding was studied in detail for the following sources:

Stream	Limit of Detailed Study
Charles River	from upstream of the New Charles River Dam to the upstream corporate limits and from the Boston-City of Newton corporate limits to the Boston-Town of Dedham corporate limits;
Mother Brook	from the Boston-Dedham corporate limits to its confluence with the Neponset River;
Muddy River	from Leverett Pond to its confluence with the Charles River;
Neponset River	from upstream of the dam at Lower Mills to the Boston-Dedham corporate limits; and
Stony Brook	from upstream of the entrance to the Stony Brook culvert to Turtle Pond.

Portions of the Muddy River within the detailed study limits are referred to locally as the Back Bay Fens. Wherever referenced in this report, the name Muddy River shall be assumed to include the area known as the Back Bay Fens. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through December 1992.

The upper reach of the Muddy River, a branch of Stony Brook, Sawmill Brook, Chestnut Hill Reservoir, Chandler's Pond, Jamaica Pond and other areas were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Boston.

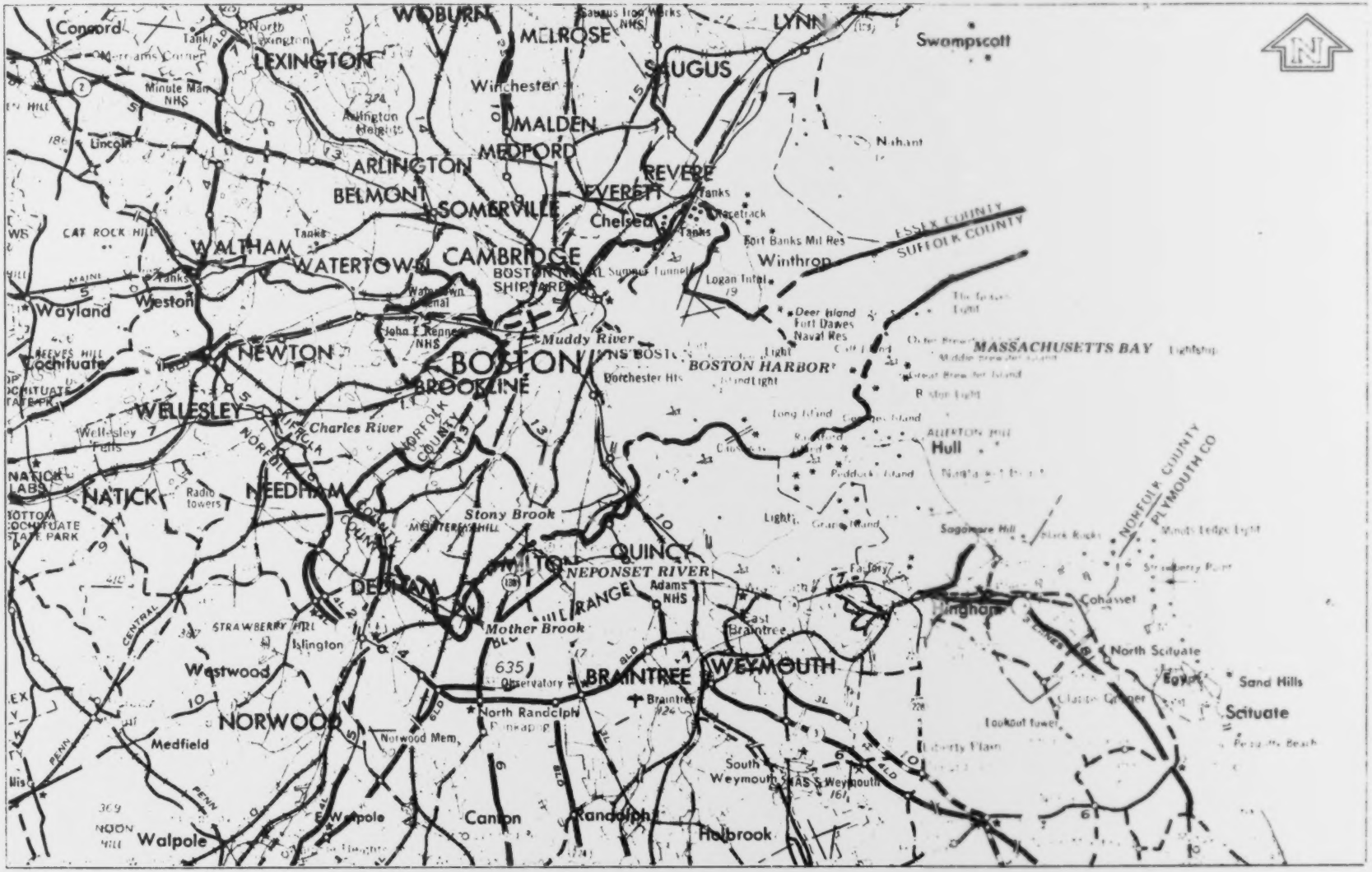


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

APPROXIMATE SCALE
4 0 4 8 12 MILES

VICINITY MAP

2.2 Community Description

The City of Boston is located on the seacoast of the Atlantic Ocean, in Suffolk County, eastern Massachusetts. It is bordered by the Atlantic Ocean on the east; by the Cities of Cambridge, Somerville, Everett, Chelsea, Revere, and the Towns of Watertown and Winthrop on the north; the Towns of Brookline and Needham, and the City of Newton on the west; and by the Towns of Dedham, Canton, Milton, and the City of Quincy on the south. It is 44 miles from Providence, Rhode Island, 106 miles from Portland, Maine, and 93 miles from Hartford, Connecticut.

The City of Boston encompasses an area of 43.18 square miles, with a population of 641,071 in 1970. It is estimated by the Metropolitan Area Planning Council that Boston will continue to lose its population. The 1990 estimated population by the same source is 606,300, a decline of nearly six percent from the 1970 figure. However, it is the hub of a larger metropolitan area serving some 3.25 million people; the sixth largest population center in the United States.

Boston was originally a peninsula with great areas of salt marsh on the north, along the banks of the Charles and Mystic Rivers, and at the mouth of the Neponset River to the south. Large areas of filled land occur in the Back Bay, the West End, South Boston, Dorchester, Charlestown and East Boston. In 1910, a dam on the Charles River at Leverett Street was constructed to prevent tidal flooding of the lowlands, to cover unsightly tidal flats at the mouth of the river, and to create an aesthetically pleasing recreational pool - now known as the Charles River Basin.

However, the creation of the basin accelerated growth along its banks, which in turn has resulted in the conversion of many former open spaces to developed and paved areas. This change has increased the speed and amount of runoff above the existing dam, making it inadequate to carry the discharges predicted. The U. S. Army Corps of Engineers (COE) is constructing a new dam at Warren Avenue to replace the 1910 dam at Leverett Street in order to accommodate the increased runoff.

The land throughout the City of Boston is densely settled, except for limited areas in the west. Land use is divided in the following manner: 35.6 percent residential; 22.5 percent parks, cemeteries, airport, and reserves; 22.7 percent commercial; 4.4 percent industrial; 9.0 percent water and wetlands, and 5.8 percent vacant.

The topography of the area is generally level, with elevations ranging from sea level to 100 feet. Occasional hills, composed of glacial till, rise as high as 300 feet. The tidal shoreline along the Atlantic Ocean is 87.7 miles in length.

The Charles River has its headwaters in Echo Lake in Hopkinton. It flows generally northeast, finally becoming the northern boundary of the City of Boston, before discharging into Boston Harbor. It has a drainage area of approximately 300 square miles. Mother Brook, beginning as a partial diversion of the Charles River in the Town of Dedham, flows east through the Hyde Park section of Boston, discharging into the Neponset River. Flows in Mother Brook are limited to approximately one-third that of the Charles River. Muddy River rises out of Jamaica Pond and flows north, passing through highly-developed areas of Boston and Brookline before discharging into the Back Bay Fens. The Fens then empty into the Charles River Basin. The Neponset River originates in the Neponset Reservoir in Foxborough. It flows generally northeast, becoming the southern boundary for the City of Boston before discharging into Dorchester Bay. Stony Brook originates in Turtle Pond and flows south through Stony Brook Reservation before entering the Stony Brook culvert.

Boston Harbor is bordered by the Atlantic Ocean to the east and is protected on the north by Winthrop Peninsula and to the south by Hull Peninsula. From north to south, Boston Harbor is bounded by the Logan International Airport, East Boston, Charlestown, the Mystic and Charles Rivers, the downtown area, South Boston, Dorchester, and the Neponset River. The harbor has a number of islands including Deer, Spectacle, Thompson, Long and Gallops Islands. The entire coastline is densely developed, and much of the waterfront is under redevelopment pressure. Much of the recent construction has involved the downtown waterfront area, including condominiums, offices, parks and commercial establishments.

2.3 Principal Flood Problems

Investigations into flooding within the corporate limits of Boston have revealed that there has been severe flooding resulting in extensive damage, especially to the Charles River Basin and the surrounding lowlands. The problem is caused primarily by the difference between the established normal water level in the basin and the high tide in the harbor. In the flood of August 1955, 12.5 inches of rain coupled with a peak high tide of 8.2 feet resulted in raising the basin elevation to a record high of 6.90 feet. Over 1,750 acres, mostly highly-developed Cambridge and Boston, lying along the 8.6-mile long basin were subject to serious flooding. The 1955 hurricane, equivalent to a 100-year storm, resulted in flood damage along the lower Charles River amounting to 5.5 million dollars. The same flood level in 1980 would have resulted in an estimated damage of 20 million dollars. In March 1968, 7.7 inches of rain combined with the spring thaw produced the second highest basin levels of 5.25 feet, inundating many areas along Storrow Drive. Although the peak discharge upstream was the same as the 1955 flood, the river peak did not coincide with the tidal peaks as in the 1955 flood, and resulting damage was less extensive.

Flooding problems from the 1955 and 1968 storms also occurred along the Neponset River in the Hyde Park area. Numerous private properties, automobiles and roadways were damaged as a result of the storm.

Flooding also occurs along the coastline, the most recent example of severe flooding being during the northeaster of February 1978, which was comparable to a 100-year flood event. Elevations of flooding ranged from 9.35 to 10.85 feet, which caused one to three feet of flooding in areas such as Rowes, India, Long, Commercial and Battery Wharves. Low-level flooding occurred at a number of East Boston locations such as East Boston Pier, the airport access road, and several parking lots on commercial piers. More serious damage occurred as a result of wave action, such as the dislodgment of the ship Peter Stuyvesent from its berth at Pier 4. The recorded flood elevation was 10.55 feet at the New Charles River Dam, 10.25 feet at the U.S.S. Constitution, and 10.30 feet at the Commonwealth Pier gage.

2.4 Flood Protection Measures

The primary flood problem within the City of Boston is in the area along the Charles River Basin. This results from raised water levels of the Charles River Basin, outflow of the tributaries and backup from the basin, due to lack of efficient control of the basin level. The COE is presently constructing a new dam at Warren Avenue about 0.4 mile downstream of the existing structure. Upon completion, the new dam will provide an additional 25 acres of surface area to the basin and a maximum pumping capacity of 8,400 cubic feet per second (cfs). This pumping capacity will effectively maintain the basin elevation at a near-normal level of 4.3 feet during a 100-year flood event and prevent any serious flooding problems along the Charles River Basin. The Metropolitan District Commission (MDC) has completed a flood control project on the Neponset River for the reach from the freshwater limit to upstream of the Neponset Valley Parkway and CONRAIL crossing. This project includes channel straightening and channel and bridge modifications. These measures in conjunction with proper operation of the floodgates on the dams, will effectively contain the 100- and 500-year floods within the channel banks. Much of the land bordering riverine areas has been designated as parkland, thereby limiting development in floodplain areas. Flood control measures along the harbor are scattered, but include such measures as seawalls and rip-rapping.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that

are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency and peak elevation-frequency relationships for each flooding source studied in detail affecting the community.

Peak discharge estimates for the upper reach of the Charles River for the 10-, 50-, 100- and 500-year floods were based on a log-Pearson Type III analysis of the USGS gage data from the gages (no. 01104500 and no. 01103500) located at Waltham and Charles River Village, respectively (Reference 1).

As a result of the 8,400 cfs pumping capacity of the New Charles River Dam, peak discharge estimates for the Charles River Basin for floods of the selected recurrence intervals were not determined. Peak inflow hydrographs developed by the COE were used to determine pumping curves so as to maintain basin levels near the normal elevation of 3.3 feet during the 10-, 50-, and 100-year floods (Reference 2). Damage resulting from floodwaters along the Charles River Basin begins at an elevation of 4.6 feet. During a 100-year event, the pumping station will control basin levels to an elevation of 4.3 feet, which is below the level at which damage will occur. For the 500-year event, basin levels will be held to an elevation of 6.0 feet and minimal damage will result. This assumes, however, that the basin will not be drawn down and that sluicing will not be possible.

Mother Brook acts as a diversion channel from the Charles River to the Neponset River. The discharges for Mother Brook are limited by law to approximately one-third of the peak discharge for the Charles River (Reference 3).

Peak discharge estimates for the Muddy River and Back Bay Fens for floods of the selected recurrence intervals were not calculated, as the Muddy River and Back Bay Fens act as a reservoir during periods of great runoff. For this reason, hydrologic analyses were conducted to establish peak volume rather than peak discharge-frequency data. Flood volume data was developed by the COE using unit hydrographs and rainfall-frequency analyses (References 2 and 4). This data was checked for reasonableness and incorporated into this study.

Peak discharge-frequency estimates of the Neponset River for the 10-, 50-, 100- and 500-year floods were determined for the Flood Insurance Study for the Town of Milton and were incorporated into this study (Reference 5).

Peak discharge-frequency estimates for Stony Brook for the 10-, 50-, and 100-year floods were computed using the SCS peak discharge determination methods for small watersheds (Reference 6). The 500-year peak discharge estimate was determined by linear extrapolation of a log-Pearson Type III probability curve on the other floods.

A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CHARLES RIVER					
At upstream (Boston-Dedham) corporate limits	227.0	2,125	3,102	3,578	4,850
MOTHER BROOK					
At corporate limits	2.4	740	1,210	1,470	2,250
NEPONSET RIVER					
At dam at Lower Mills	98.0	2,450	3,410	3,730	4,750
STONY BROOK					
At Stony Brook culvert	13.0	90	150	200	286

The coastal areas for which flood elevations have been determined include the lands bordering Massachusetts Bay, Boston Harbor, and Dorchester Bay, and along the Neponset, Charles, Mystic, and Chelsea Rivers to the limits of tidal inundation. Water level fluctuations

above astronomical tide levels at Boston are caused primarily by the passage of hurricanes and winter storms known as northeasters. Of these, the northeasters produce the more frequent and severe storm tides.

Extreme water levels along the Boston shoreline are caused by the combination of storm surges and high astronomical tides. Astronomical tide levels are extremely important in the determination of total water levels as they have a mean range of 9.5 feet and a spring range of more than 12 feet. These ranges are considerably larger than the expected storm surges, thus making the phasing of the astronomical tide critical to the determination of total water levels.

Storm surges in the Boston area are caused mainly by onshore winds, wave setup and low barometric pressures that cause a rise in the water-surface elevation. As discussed above, these water level fluctuations are due primarily to the passage of hurricanes and northeasters through the area. The dominant surge-producing storm in the Boston area, as in most of the New England regions, is the northeaster. These storms are typically less intense than hurricanes, but they occur more frequently and are larger and slower-moving. Thus, they have a significantly greater probability of combining with a high astronomical tide causing an extreme high-water level. Hurricanes in the New England region are considerably weaker than the very destructive storms found in the Gulf of Mexico and off the southeastern coast of the United States. In addition, at relatively high rates of seep. These factors, along with the relatively narrow continental shelf off Boston, combine to reduce the effect of the hurricanes on the tide levels at the coast.

A combined probabilistic-deterministic method was used in this study to develop the coastal stillwater flood elevations in locations where tidal gage records are not available. The probabilistic components of the study involved the determination of probabilities of occurrence of various meteorological parameters that define hurricanes and winter storms in the area. These probabilities are effectively constant over large regions and thus may be used at locations where no direct measurements has been made with no significant loss in accuracy. The deterministic component of the study involved the calculation of the storm surge that would be caused by various combinations of these meteorological parameters. The main steps involved in the determination of flood levels are as follows:

1. Determination of probabilities of occurrence of various meteorological parameters relevant to storm surge generation.

2. Development of numerical models to calculate the storm surge due to a particular set of meteorological conditions. Numerical models were developed to represent the outer coast, inner harbor and riverine areas.

3. Development of simple numerical models to allow rapid and inexpensive calculation of surge levels at various locations.

4. "Calibration" of the simple numerical model to specific locations of interest using the results of the more comprehensive numerical models.

5. Simulation of 500 years of storm tide data using a random generation of meteorological parameters based on their historical probabilities of occurrence and combination with a randomly phased astronomical tide.

6. Calculation of stillwater elevation return periods on the basis of the simulated tide data.

A total of six numerical models were developed to calculated surge levels on the open coast and inside the harbor. These models included:

WINTSRG - used to determine the open coast surge due to winter storms.

HURSRG - used to determine the open coast surge due to hurricanes.

INSRG - used to determine the surge at various locations inside the harbor due to either winter storms or hurricanes using the output of WINTSRG or HURSRG as boundary conditions.

RIVSRG - used to determine the surge at various locations along the riverine sections due to either winter storms or hurricanes using the output of INSRG as boundary conditions.

WINTSEL - used to determine the total stillwater elevations due to the combination of astronomical tides and storm surges from winter storms for the development of 500 years of record.

HUSEL - used to determine the total stillwater elevations due to the combination of astronomical tides and hurricane surges for the development of 500 years of record.

The development of these models is discussed in detail in the Coastal Flooding Analysis (Reference 7). Briefly, the HURSRG, INSRG, and RIVSRG models were developed based on the solution of the governing differential equations outlined by Dean. The WINTSRG model was developed to account for the special conditions caused by winter storms that control the development of open coast surge levels. These models were used to develop surge time histories due to various combinations of the meteorological parameters, which define the storms. Regression analyses were performed to determine the response of the harbor to each of the parameters while limiting the number of computer runs using the comprehensive numerical models required.

The WINTSEL and HURSEL models were developed to randomly generate winter storm and hurricane parameters respectively, and the resulting storm tides. The storm tides were calculated using simple numerical models based on the regression analyses performed using the comprehensive numerical models described above.

The numerical models were verified on the basis of historical storm records and the continuous recording form the National Ocean Survey tidal gage located on Commonwealth Pier.

Stillwater elevations were generated for return periods of 10-, 50-, 100-, and 500-years. In addition, a number of observations on the character of the storms and the surge levels affecting Boston were made. In general, it was found that winter storms were the dominant cause of high water levels on the open coast and in the harbor. It was also found that waves contribute a significant portion of the open coast winter storm surge and that these surges can be calculated with sufficient accuracy using a steady state analysis.

The study indicated that the water levels for the specified return periods are lowest at the southeastern end of Logan International Airport and increase towards Dorchester Bay and into the Charles, Neponset, Mystic and Chelsea Rivers. It was determined that the northeast winds that caused the majority of the storm surges, forced water into Dorchester Bay and against the coast causing an increase in the water levels.

Stillwater elevations for the Charles River Basin upstream of the New Charles River Dam were obtained from a 1979 COE report (Reference 8).

The stillwater elevations for the 10-, 50-, 100-, and 500-year floods have been determined for Massachusetts Bay, Boston Harbor, Dorchester Bay, the Chelsea River, the Mystic River, and the Charles River Basin and are summarized in Table 2, "Summary of Stillwater Elevations."

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
MASSACHUSETTS BAY				
At Deer and Lovell Islands	8.8	9.7	10.0	10.9
BOSTON HARBOR				
East of Logan Airport	8.5	9.3	9.6	10.4
West of Deer Island	8.7	9.6	9.9	10.7
East of Governor's Island	8.8	9.5	9.9	10.7
Northeast of Spectacle Island	8.8	9.7	10.0	10.9
Southeast of Castle Island	8.9	9.7	10.1	10.9
At Long Island	8.9	9.8	10.1	11.0
East of Thompson Island	9.0	9.9	10.2	11.1

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
DORCHESTER BAY				
At Old Harbor	9.2	10.1	10.5	11.3
West of Thompson Island	9.4	10.3	10.7	11.5
At Neponset River	9.8	11.0	11.4	12.2
BOSTON INNER HARBOR				
Entire harbor shoreline	9.0	9.8	10.2	11.0
CHELSEA RIVER				
Immediately upstream of McArdle Bridge	9.1	10.1	10.4	11.3
Immediately upstream of Chelsea Street bridge	9.3	10.2	10.6	11.4
MYSTIC RIVER				
Immediately upstream of Mystic River Bridge	9.1	9.9	10.3	11.1
CHARLES RIVER BASIN				
Immediately upstream of New Charles River Dam	3.8	4.0	4.3	6.0

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry. Overbank extensions of field-surveyed channel cross sections, and additional sections needed for hydraulic continuity were taken from topographic maps at a scale of 1:1,200 with a 5 foot contour interval (Reference 9). Present culvert conditions were used and recent modifications were taken into consideration in the use of flood marks.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations for Stony Brook, Mother Brook and the upper reach of the Charles River were developed using the HEC-2 computer program developed by the COE (Reference 10).

Water-surface elevations for floods of the selected recurrence intervals along the Neponset River were obtained from a previously published report by Anderson-Nichols Co. and the Flood Insurance Study for the Town of Milton (References 11 and 5). They were checked for reasonableness and incorporated into this study.

Elevations for the 10-, 50-, 100-, and 500-year floods for the Back Bay Fens, the Muddy River and the Charles River Basin were developed by the COE in their detailed analysis of the Charles River Basin (References 2 and 4).

For the Charles River Basin, elevations were developed using inflow hydrographs in respect to the pumping capacity of the New Charles River Dam (References 2 and 12). Elevations along the Muddy River were developed using the "modified puls" method of reservoir routing in conjunction with the discharge capacity of the Charles River Basin (References 2, 4, 12 and 13).

Starting water-surface elevations for the upper reach of the Charles River were coordinated from a previously published Flood Insurance Study for Dedham (Reference 3). Starting water-surface elevations for Mother Brook were taken from the point of confluence with the Neponset River. Starting water-surface elevations for the Neponset River were taken from the Flood Insurance Study for Dedham (Reference 3). Starting water-surface elevations for Stony Brook were taken from a rating curve developed at the entrance to the Stony Brook culvert.

Roughness factors (Manning's "n") used in the hydraulic computations were estimated based on field inspection of flood plain areas. The channel "n" and overbank "n" values for the streams studied by detailed methods are shown in the following tabulation:

Stream	Manning's "n" Values	
	Channel	Overbank
Charles River	0.025 - 0.035	0.065
Mother Brook	0.015 - 0.100	0.100
Neponset River	0.035	0.060
Stony Brook	0.020 - 0.050	0.100

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The COE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 14). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding. A wave runup analysis was performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 15). This method is based on three major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth, and the wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that the wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes, seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures described in the Users Manual for Wave Height Analysis (Reference 16). The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

The methodology for analyzing wave runup was developed by Stone and Webster Engineering Corporation (Reference 17). The wave runup computer program operates using an ensemble of deepwater wave heights, H_i, the stillwater elevation, S_*, a wave period, T_s, and beach slope, m. For the City of Boston, wave heights range from 2 feet up to the significant wave height of 19 feet; the wave period equals 7 and 14 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 100-year storm surge. Accurate topographic land-use and land-cover data are required for the coastal analyses. Maps of the study area, at a scale of 1:1,200 with a contour interval of 5 feet were used for the topographic data (Reference 9). The land-use and land-cover data were obtained by field surveys.

Wave heights and wave runup were computed along transects located perpendicular to the average mean shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Figure 2, "Transect Location Map," illustrates the location of the transects for the community.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using topographic maps, land-use and land cover data, and engineering judgment to determine the real extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes.

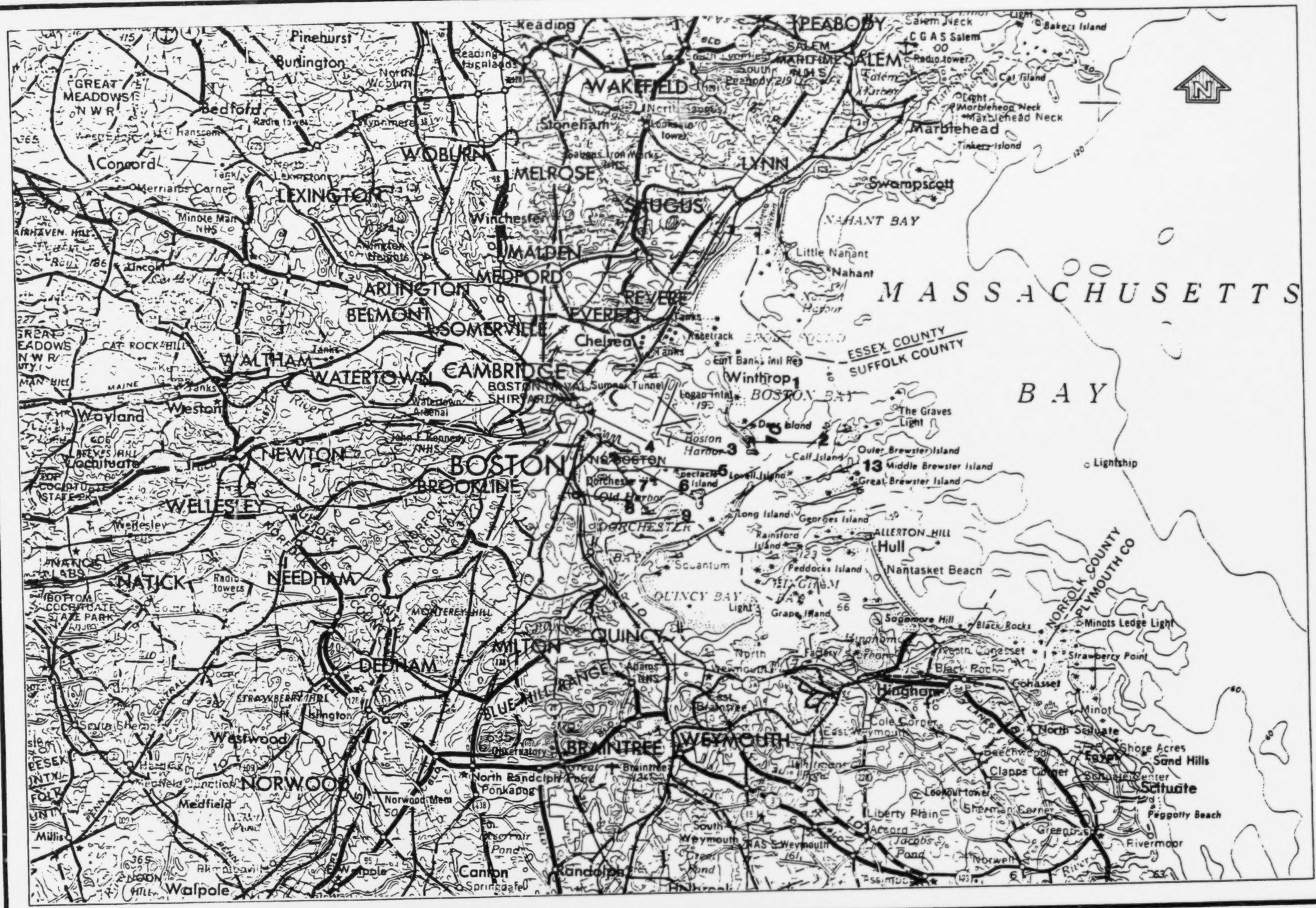
Figure 3 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave crest elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual conditions in the City of Boston may not include all the situations illustrated in Figure 3.

For areas studied by approximate methods, the 100-year floodplain boundaries were delineated using the previous Flood Insurance Study for the City of Boston (Reference 18).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. In many reports, the datum Boston City Base (BCB) is used, which is equal to NGVD plus 5.65 feet. Also used is the Metropolitan District Commission (MDC) Base, which is NGVD plus 105.65 feet. Locations of the elevation reference marks used in the study are shown on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing floodplain management measures.


Reading
PEABODY
SALEM
WAKEFIELD
Pinehurst
Burlington
GREAT MEADOWS N W R
Bedford
Concord
WOBURN
MELROSE
LEXINGTON
Winchester
SAUGUS
LYNN
Swampscott
Marblehead
NAHANT BAY
Little Nahant
Nahant
MASSACHUSETTS
BAY
MALDEN
MEDFORD
REVERE
EVERETT
ARLINGTON
BELMONT
SOMERVILLE
Chelsea
CAMBRIDGE
WALTHAM
WATERTOWN
Wayland
Weston
NEWTON
BOSTON
BROOKLINE
WELLESLEY
NATICK
NEEDHAM
DEDHAM
MILTON
QUINCY
BLUE HILL RANGE
BRAINTREE
WEYMOUTH
NORWOOD
Medfield
Walpole
Canton
Randolph
Winthrop
Boston Harbor
Deer Island
The Graves Light
Outer Brewster Island
Middle Brewster Island
Great Brewster Island
Lightship
Long Island
Georges Island
Rainsford Island
Peddocks Island
Hull
Nantasket Beach
Grape Island
Hingham
Cohasset
Minots Ledge Light
Strawberry Point
North Scituate
Scituate
Sand Hills
Egypt
Rivermoor
Peggotty Beach
Hull
ESSEX COUNTY
SUFFOLK COUNTY
NORFOLK COUNTY
PLYMOUTH CO
Salem Neck
Bakers Island
Marblehead Neck
Tinkers Island
Swampscott
Lynn
Nahant
Winthrop
Hingham
Cohasset
Scituate
Weymouth
Braintree
Quincy
Milton
Dedham
Newton
Wellesley
Natick
Needham
Wayland
Weston
Lexington
Concord
Arlington
Belmont
Somerville
Cambridge
Watertown
Waltham
Woburn
Reading
Stoneham
Melrose
Malden
Medford
Everett
Revere
Chelsea
Boston
Brookline
Norwood
Braintree
Weymouth
Randolph
Canton
Walpole
Medfield
Westwood
Needham
Dedham
Natick
Wellesley
Newton

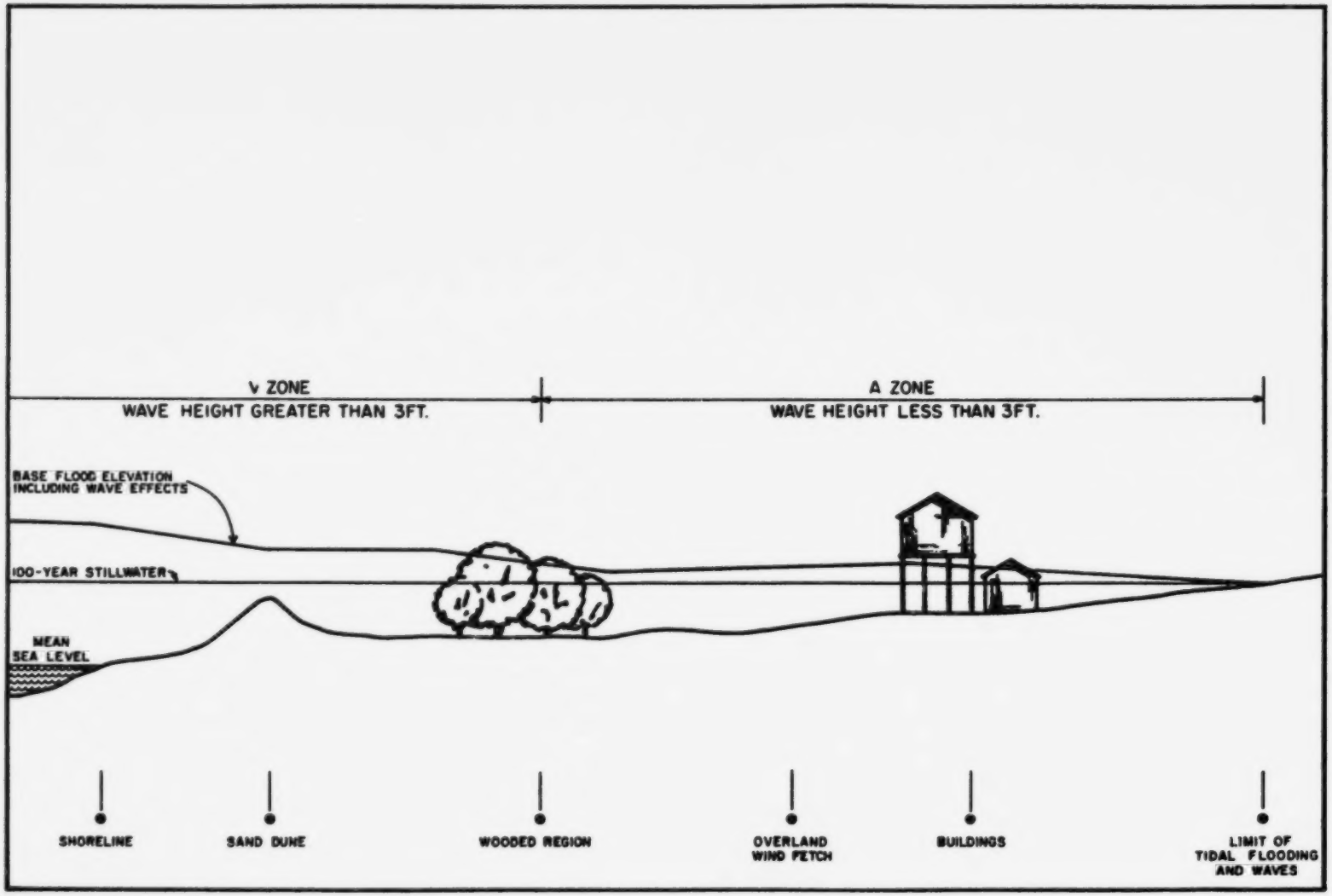


FIGURE 3
TYPICAL TRANSECT SCHEMATIC

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using topographic maps (Reference 9).

For tidal areas without wave action, the 100-year and 500-year boundaries were delineated using the topographic maps at a scale of 1:1,200 with a contour interval of 5 feet (Reference 9).

For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 100-year floodplain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

Flood boundaries for areas studied by approximate methods were obtained from the previous Flood Insurance Study for the City of Boston (Reference 18).

The 100- and 500-year floodplain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

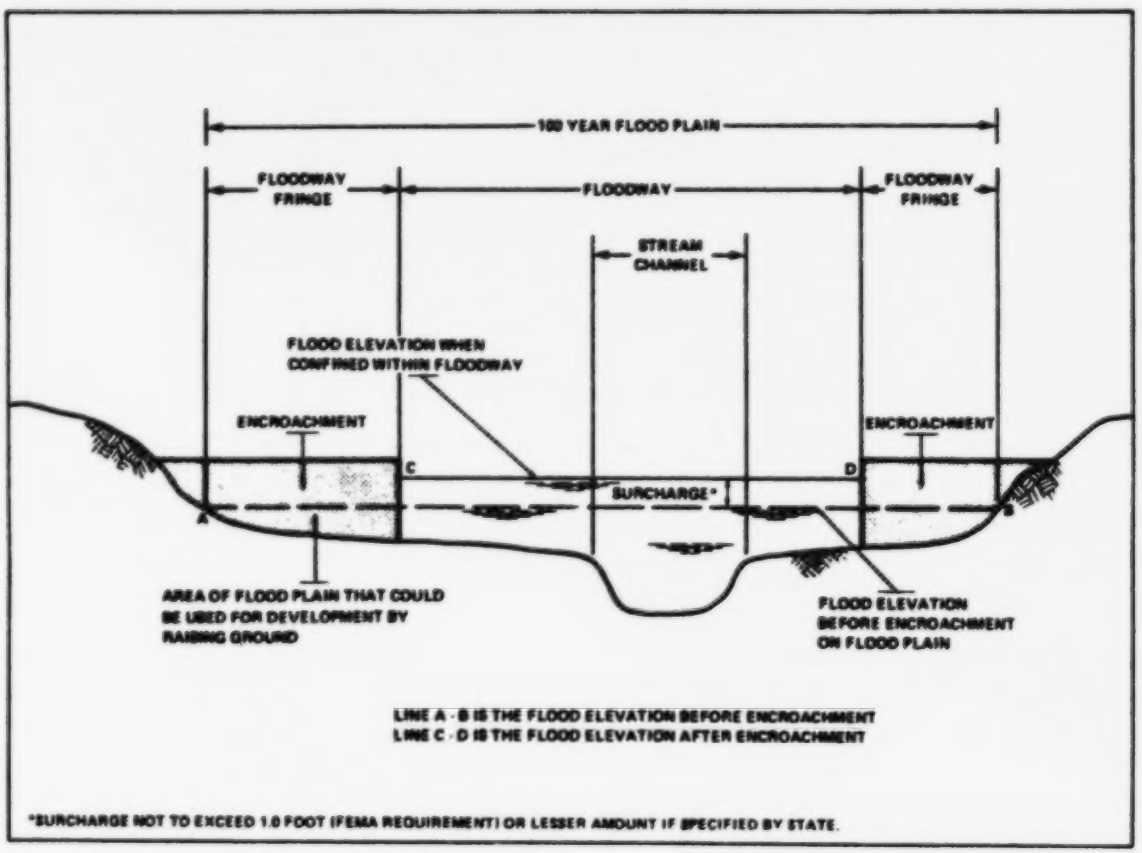
4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodway in this study is presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodway presented in this study was computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Floodway Schematic - Figure 4

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Mother Brook								
A	300	45	187	7.8	43.9	43.9	43.9	0.0
B	750	52	324	4.5	44.2	44.2	44.2	0.0
C	950	50	322	4.6	44.4	44.4	44.4	0.0
D	1,100	64	414	3.6	44.6	44.6	44.6	0.0
E	1,233	64	415	3.5	44.6	44.6	44.6	0.0
F	1,600	60	321	4.6	44.7	44.7	44.7	0.0
G	2,050	60	379	3.9	45.4	45.4	45.6	0.2
H	2,725	153	646	2.3	46.4	46.4	46.6	0.2
I	4,095	84	186	7.9	49.3	49.3	49.3	0.0
J	5,000	200	1,445	1.0	50.7	50.7	50.7	0.0
K	6,000	147	1,036	1.4	50.7	50.7	50.7	0.0
L	7,130	102	728	2.0	50.9	50.9	51.0	0.1

[1]Feet above confluence with Neponset River

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOODWAY DATA

MOTHER BROOK

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the City of Boston.

5.1 Reach Determinations

Reaches are defined as sections of floodplain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the City of Boston is shown on the Flood Profiles (Exhibit 1) and summarized in Table 4b.

In areas where wave height and wave runup analyses were performed, reaches were determined for areas of the coastline, represented by a transect or group of transects, which have the same physical characteristics. For each transect the coastal high hazard zone (V zone) may be divided into two reaches to reflect those areas where wave runup is a dominant factor and those areas where wave runup does not dominate and elevations are determined by the wave height analysis. The coastal reaches determined for the City of Boston are summarized in Table 4a.

TABLE 4a - COASTAL FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Massachusetts Bay	8.8	10.0	010	V2	12-29
			020	V4	12-15
			020	A4	10-12
			010	A2	10-15

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

TABLE 4a - COASTAL FLOOD INSURANCE ZONE DATA - continued

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Boston Harbor	8.5	9.6	015	V3	12-24
			015	A3	10-12
			010	A2	9.5
	8.7	9.9	020	V4	12
			010	A2	10-12
	8.8	9.9	015	V3	12-15
			015	A3	10-12
	8.8	10.0	010	V2	14-28
			010	A2	10
	8.9	10.1	010	V2	14-21
			020	V4	12-15
			020	A4	10-12
			010	A2	10-21
	8.9	10.1	010	V2	13-25
			020	V4	12-14
			020	A4	10-12
			010	A2	10
	9.0	10.2	010	V2	15-25
			020	V4	12-14
			010	A2	10-12
Dorchester Bay	9.2	10.5	010	V2	17-22
			020	V4	13-15
			020	A4	11-15
			010	A2	10.5
	9.4	10.7	015	V3	15-25
			015	A3	10.5
	9.8	11.4	025	V5	14-16
			020	A4	12-13
			015	A3	11-25
			015	A3	11.5
Boston Inner Harbor	9.0	10.2	020	V4	12-14
			020	A4	10-12
			010	A2	10-11
Chelsea River	9.1	10.4	015	A3	10.5
	9.3	10.6	015	A3	10.5
Mystic River	9.1	10.3	010	A2	10.5
Charles River Basin	3.8	4.3	010	A2	4.5

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Charles River							
Reach 1	07, 13	-2.6	-1.7	+5.1	025	A5	Varies
Reach 2	01, 03, 04, 05	-0.5	-0.3	+1.7	005	A1	4.5
Mother Brook							
Reach 1	21	-1.7	-0.5	+1.9	015	A3	Varies
Muddy River							
Reach 1	04, 10	-1.5	-0.6	+0.6	015	A3	Varies
Reach 2	09, 10	-2.5	-0.5	+0.5	025	A5	Varies
Reach 3	09	-4.0	-1.5	+2.5	040	A8	Varies
Neponset River							
Reach 1	21, 22	-1.3	-0.4	+1.3	015	A3	Varies
Reach 2	21, 28	-2.5	-1.2	+5.8	025	A5	Varies
Reach 3	28	-4.0	-1.0	+5.9	040	A8	Varies
Stony Brook							
Reach 1	21	-6.0	-1.0	+6.5	060	A12	Varies
Reach 2	21	-0.7	-0.3	+0.3	005	A1	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average

TABLE 4B

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD INSURANCE ZONE DATA

CHARLES RIVER, MOTHER BROOK, MUDDY RIVER, NEPONSET RIVER AND STONY BROOK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Atlantic Ocean (Tidal flooding affecting Boston Harbor)							
Reach 1	05, 06, 10, 11, 12, 17, 18, 24, 25	-1.2	-0.4	+0.8	010	A2, V2	Varies
Reach 2	05, 06, 16, 17, 22, 23, 24	-1.3	-0.4	+0.8	015	A3, V3	Varies
Atlantic Ocean (Tidal flooding affecting Massachusetts Bay)							
Reach 1	18, 25, 26	-1.2	-0.4	+0.8	010	A2, V2	10.0

[1]Flood Insurance Rate Map Panel
[2]Weighted Average

TABLE 48

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD INSURANCE ZONE DATA

ATLANTIC OCEAN

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A1,A2,A3, A4,A5,A8, and A12:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF.
Zones V2,V3, and V4:	Special Flood Hazard Areas along coasts inundated by the 100-year flood as determined by detailed methods, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Tables 4a and 4b.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Boston is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. Base flood elevations in tidal areas and the Charles River Basin were shown to the nearest one-half foot. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FEMA.

6.0 OTHER STUDIES

Due to its highly developed state, the City of Boston has been subject to numerous flood-related studies as a result of construction proposals, waterway improvements, water quality assessments and flood plain management studies.

The Charles River and the lower Charles River Basin have been extensively studied by the COE, SCS, and C. E. Maguire, Inc., as a result of its serious flood problems (References 2, 4 and 12). Elevations for the floods of the selected recurrence intervals, discharge data, inflow hydrographs and other pertinent hydrologic and hydraulic data were adopted in this Flood Insurance Study, as were flood elevations for the Muddy River.

Flood elevations for the Neponset River and Mother Brook were coordinated with detailed studies done in 1971 and 1973 (References 11 and 19). Elevations were coordinated with the Flood Insurance Studies of the surrounding Cities of Quincy and Newton, and Towns of Milton, Dedham, Needham, Brookline, and Winthrop (References 20, 21, 5, 3, 22, 23 and 24). No information was available for the Cities of Cambridge, Chelsea and Revere.

Tidal elevations for Boston Harbor were coordinated with the frequency curve developed by the COE for the tidal gage at Commonwealth Pier, and were checked with historical elevations recorded by the USGS during the flood of February 1978 (Reference 8).

The Flood Hazard Boundary and Flood Insurance Rate Maps were prepared on topographic maps of Boston provided by the Boston Redevelopment Authority (Reference 9). Although these represent the best available maps, they are 15 years old, and a number of areas may be out of date, causing inaccuracies in the flood boundary delineations. The analyses prepared

for this study include a more detailed and up-to-date coastal analysis than the Flood Insurance Studies for Milton, Quincy and Winthrop. Therefore, base flood elevations and flood insurance zones computed in this study may differ from the results of those previous studies. Because of the increased pumping capacity of the New Charles River Dam, the flood elevations for the Charles River Basin in this study are lower than those computed in the Newton Flood Insurance Study. Also, the flood boundaries delineated for the Charles River at the Boston-Newton corporate limits in this study do not agree with those shown in the Newton Flood Insurance Study because more detailed topographic maps were used in this study than in the previously published study. Flood elevations for Mother Brook at the Boston-Dedham corporate limits are slightly higher in this study than in the Dedham Flood Insurance Study because of more up-to-date hydraulic analyses.

Due to its more up-to-date nature, this study supersedes the previous Flood Insurance Study for the City of Boston (Reference 18).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

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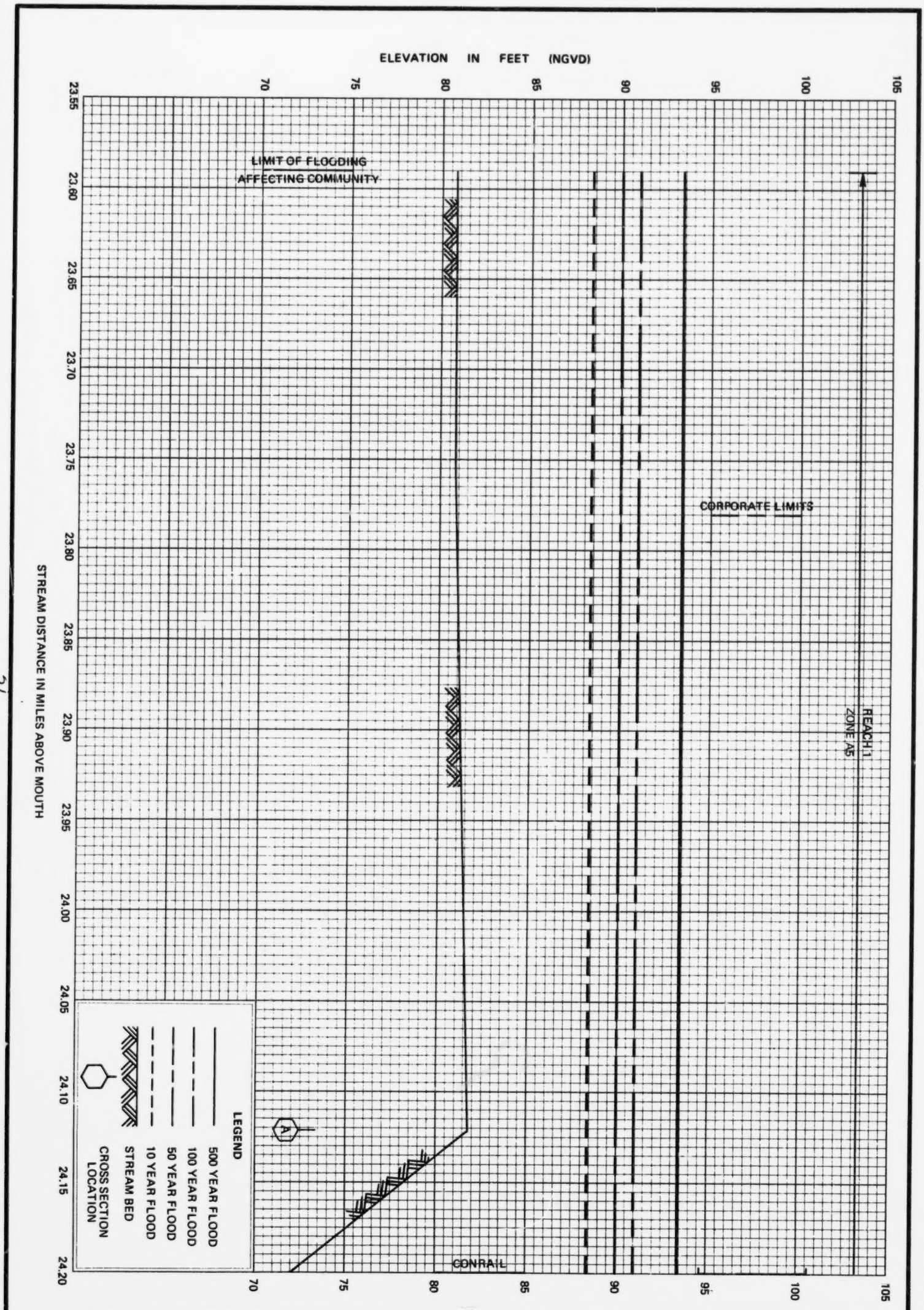
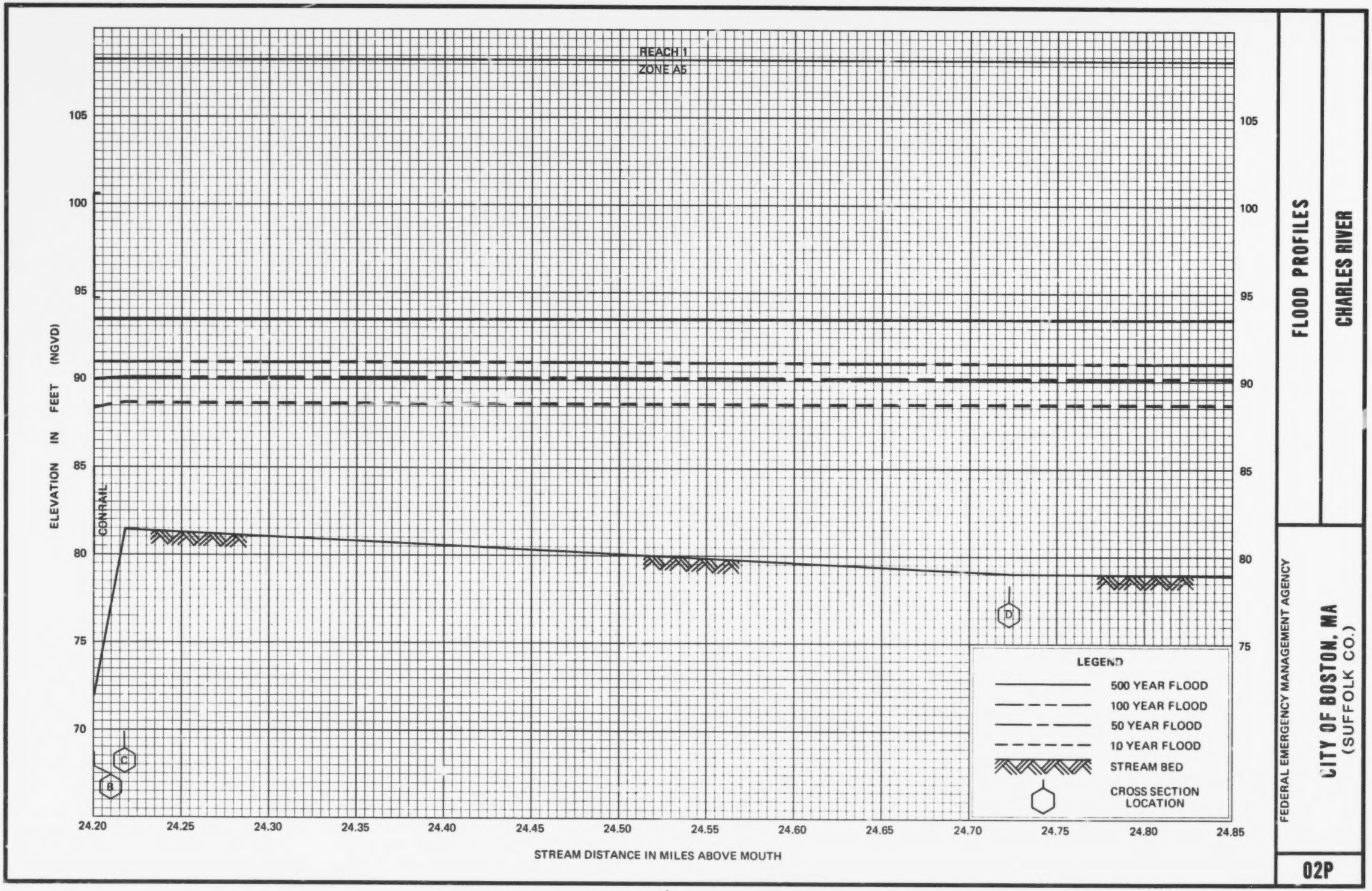
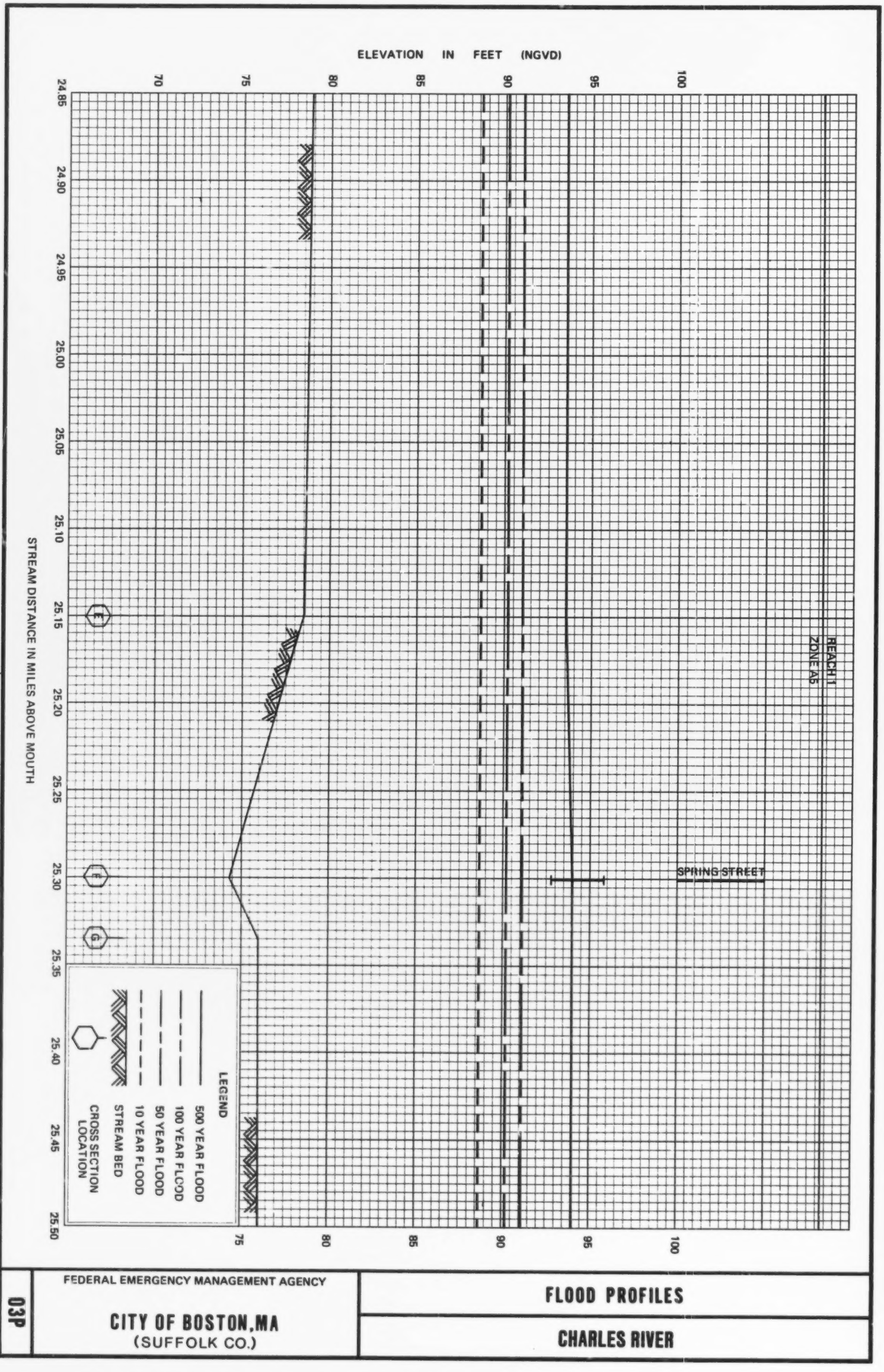


37

01P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF BOSTON, MA** (SUFFOLK CO.)	**FLOOD PROFILES** **CHARLES RIVER**


REACH 1
ZONE A5
ELEVATION IN FEET (NGVD)
105
100
95
90
85
80
75
70
CONRAIL
C
B
D
24.20
24.25
24.30
24.35
24.40
24.45
24.50
24.55
24.60
24.65
24.70
24.75
24.80
24.85
STREAM DISTANCE IN MILES ABOVE MOUTH
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
CHARLES RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF BOSTON, MA
(SUFFOLK CO.)
02P



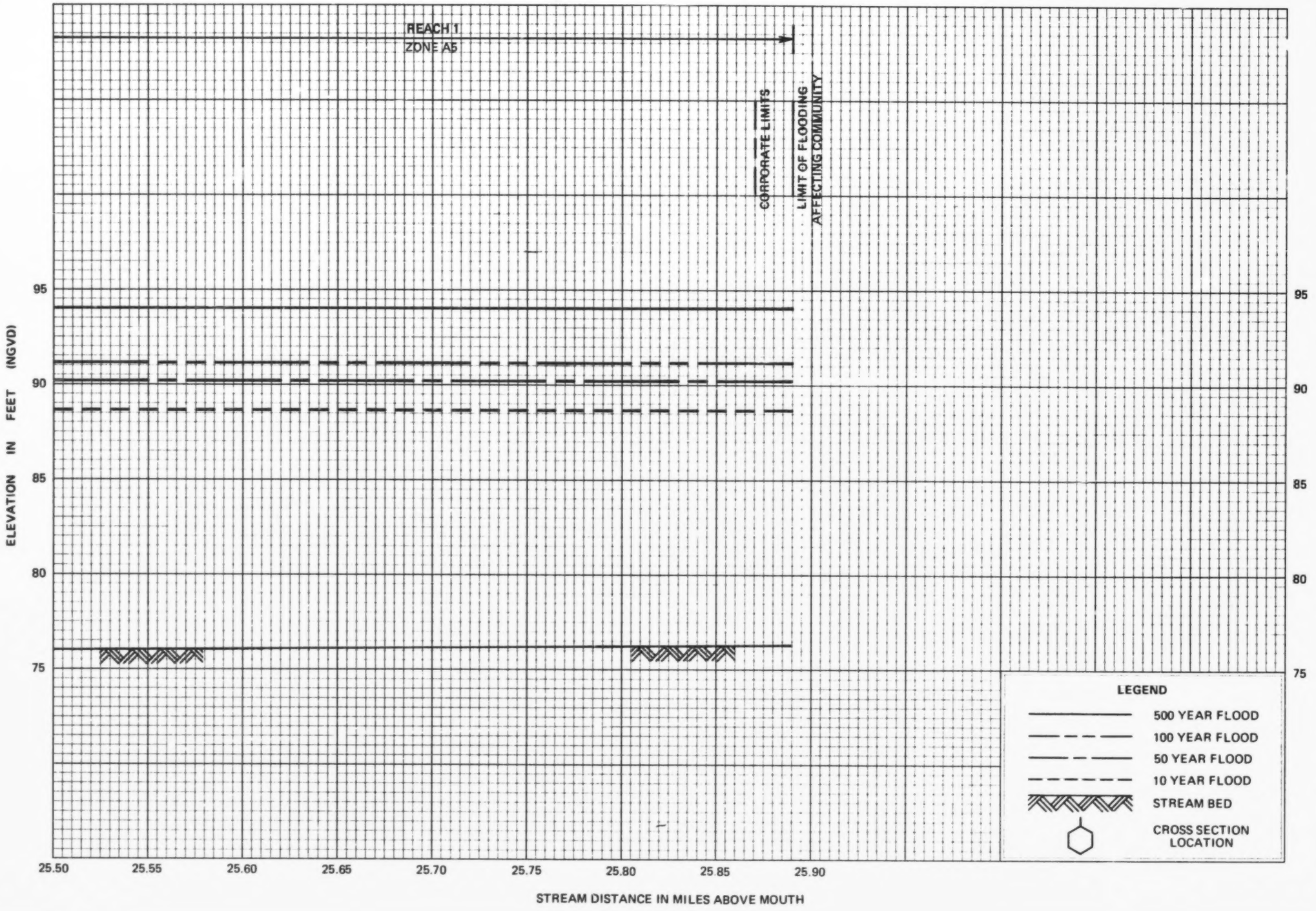
03P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

CHARLES RIVER



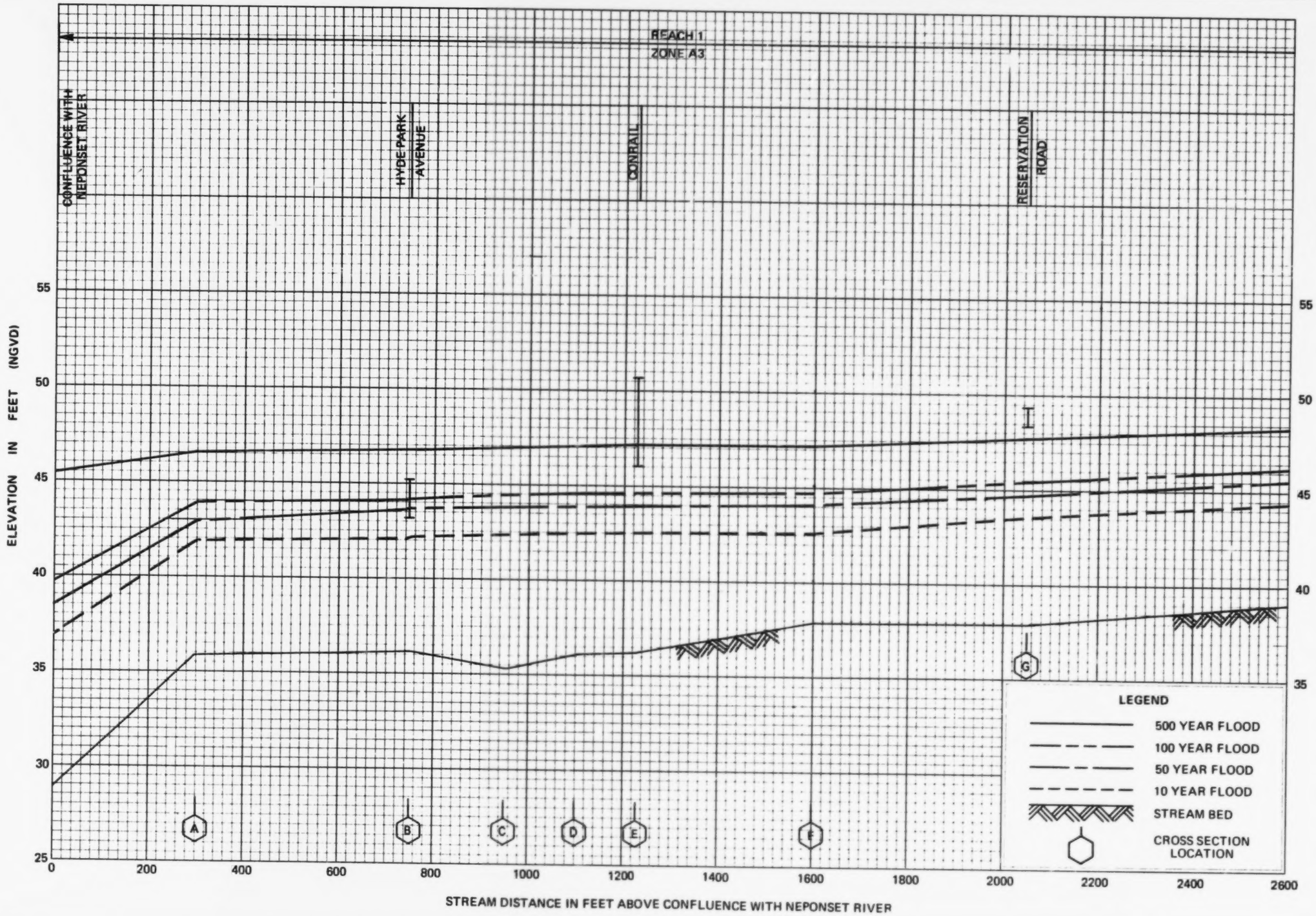
FLOOD PROFILES

CHARLES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

04P



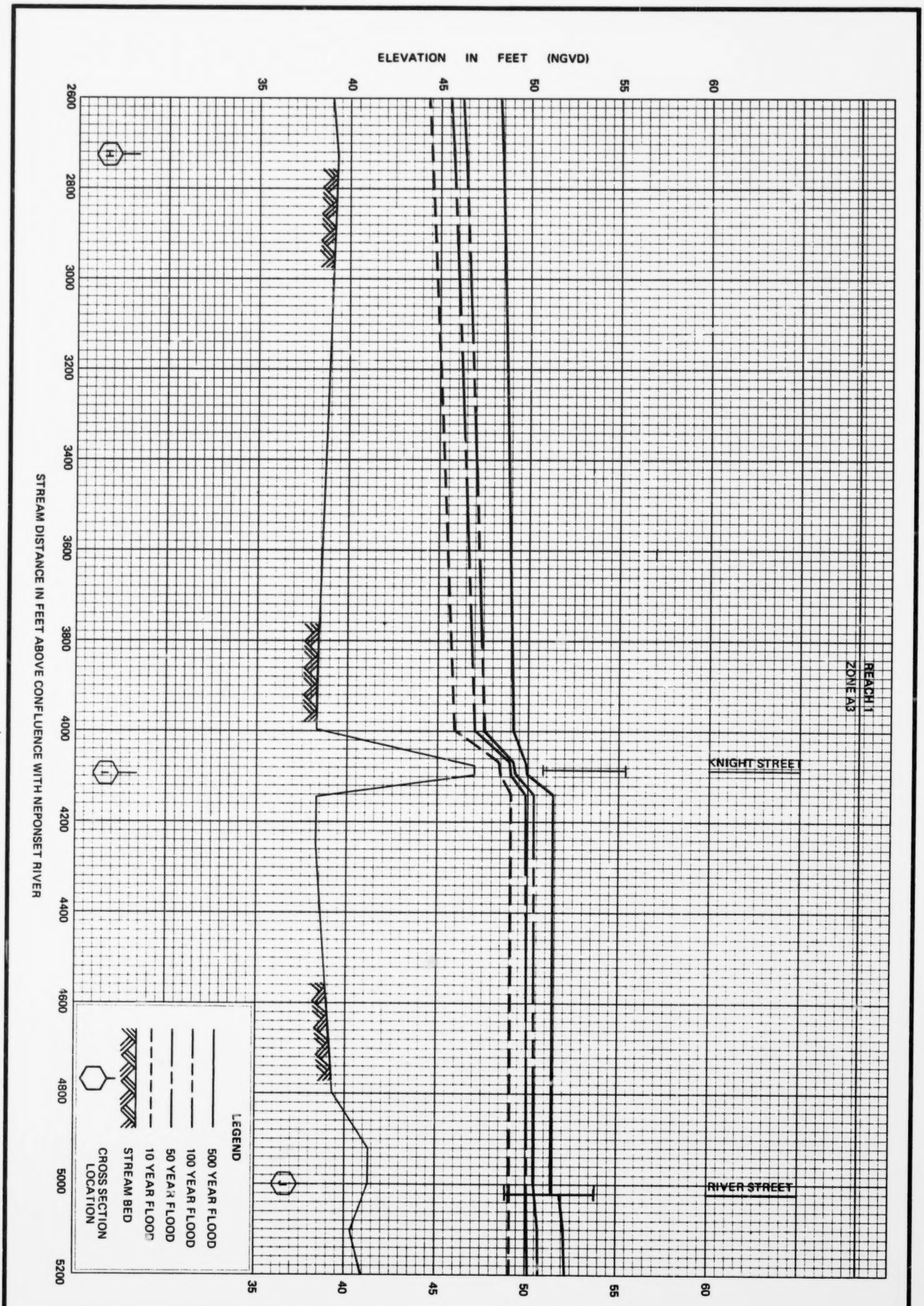
FLOOD PROFILES

MOTHER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

05P



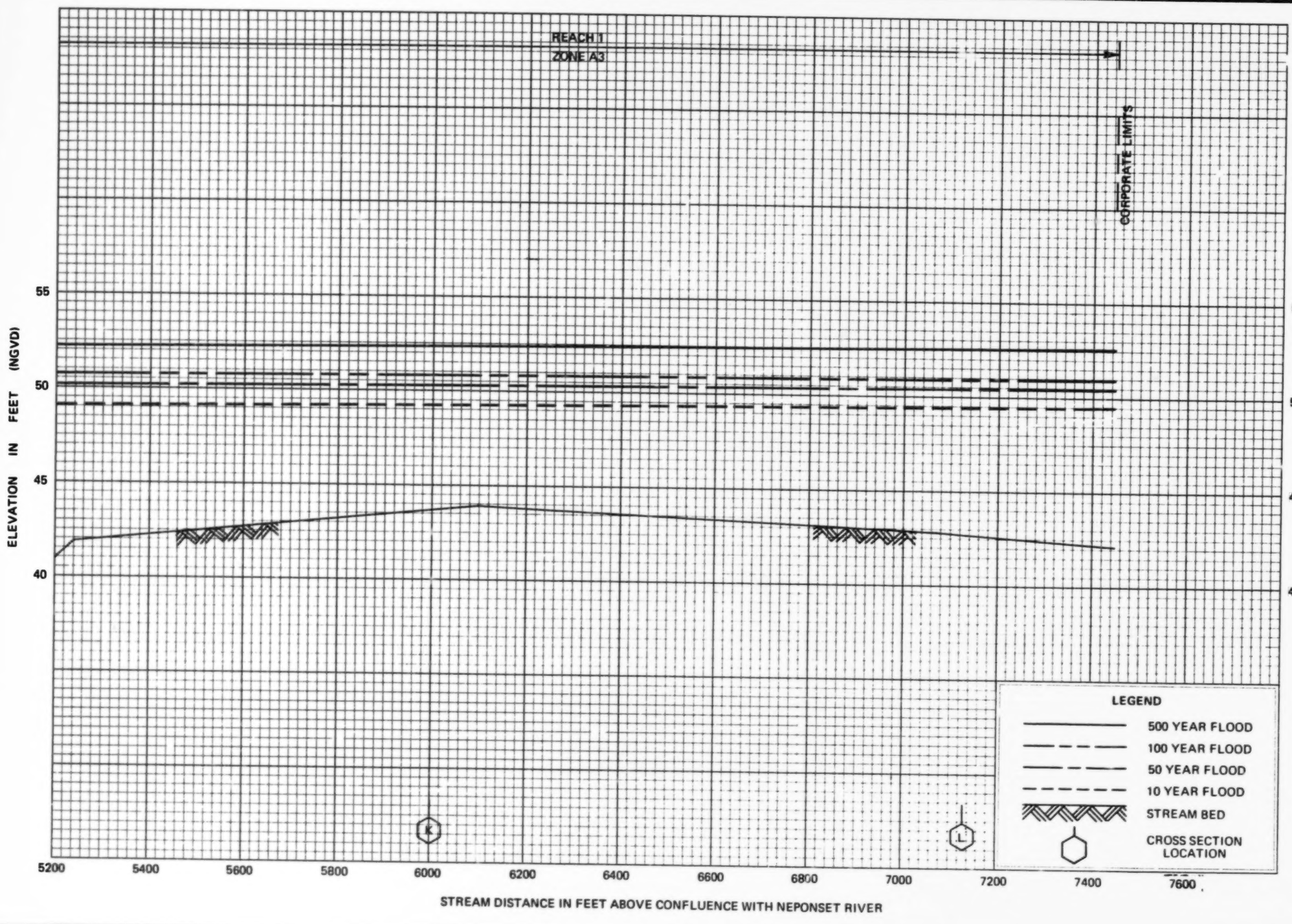
06P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

MOTHER BROOK



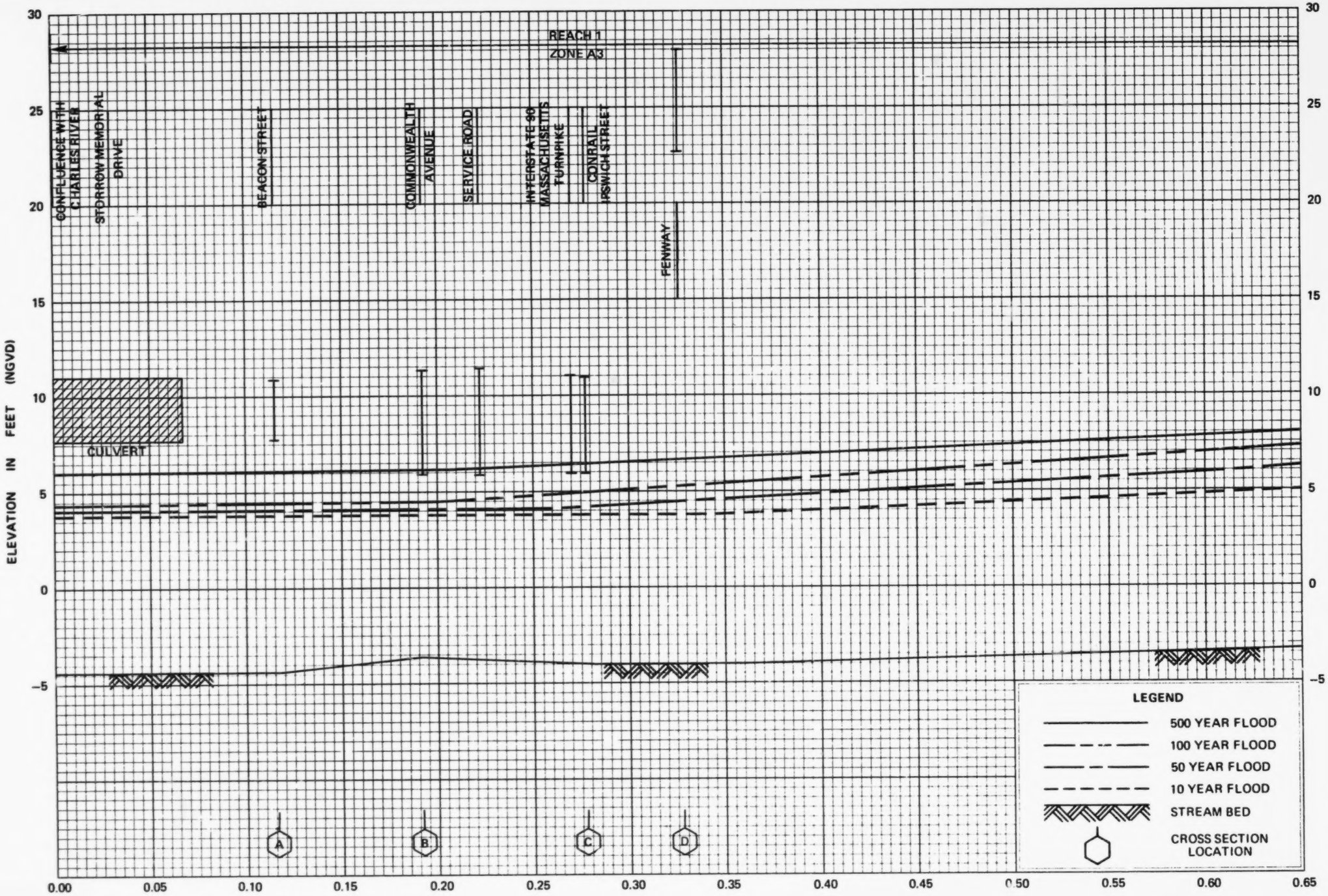
FLOOD PROFILES

MOTHER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

07P



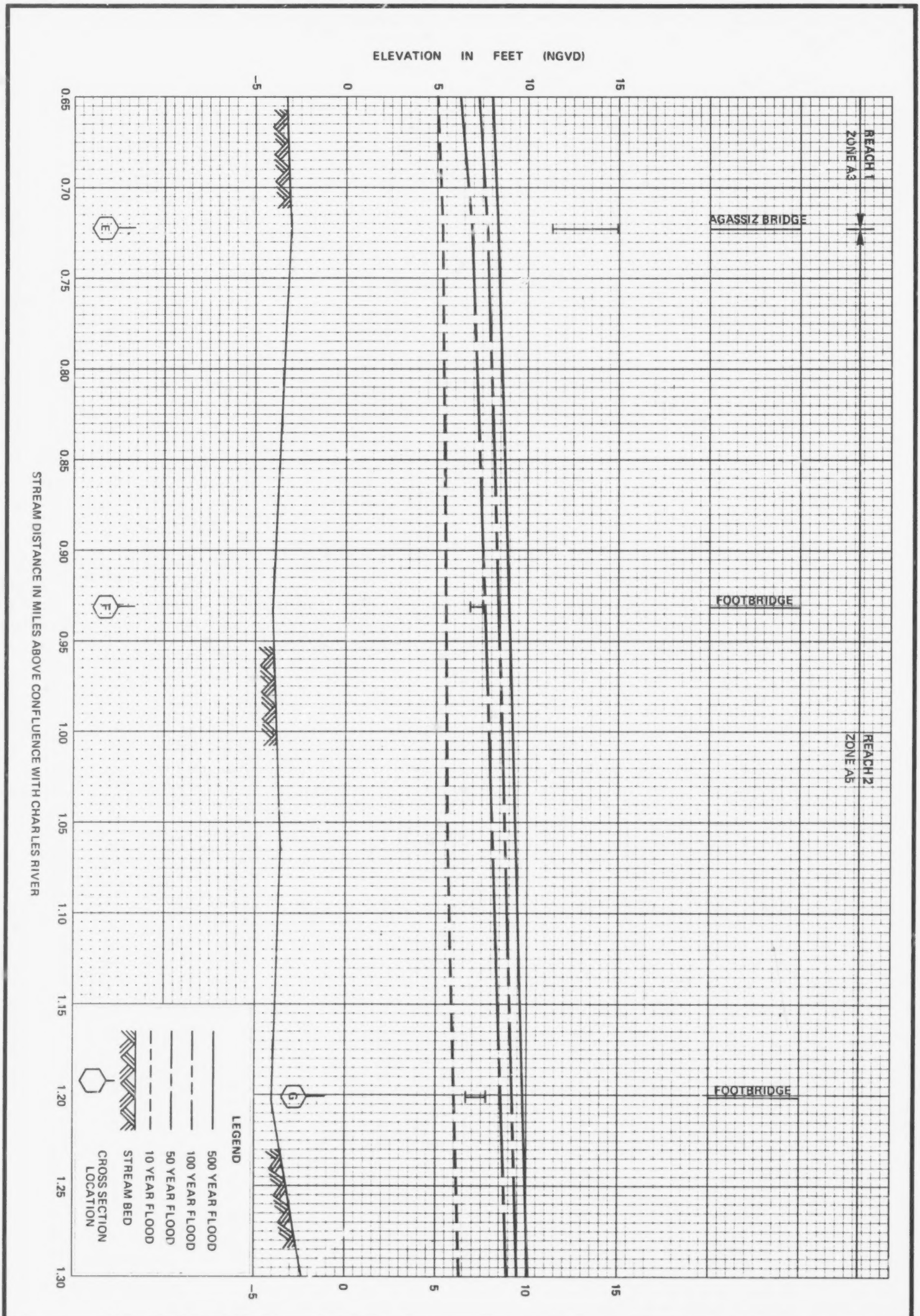
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

08P



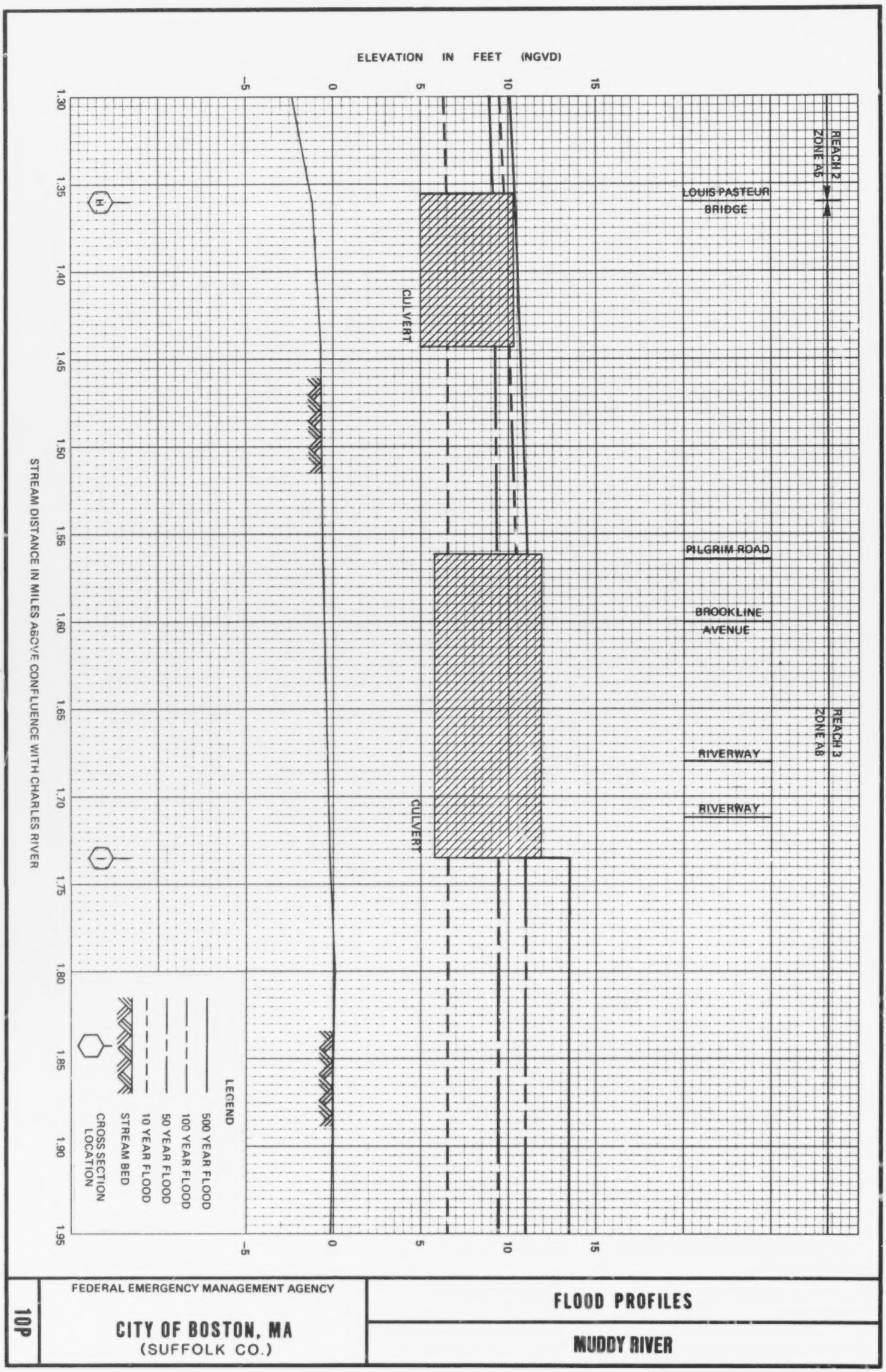
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

MUDDY RIVER

09P



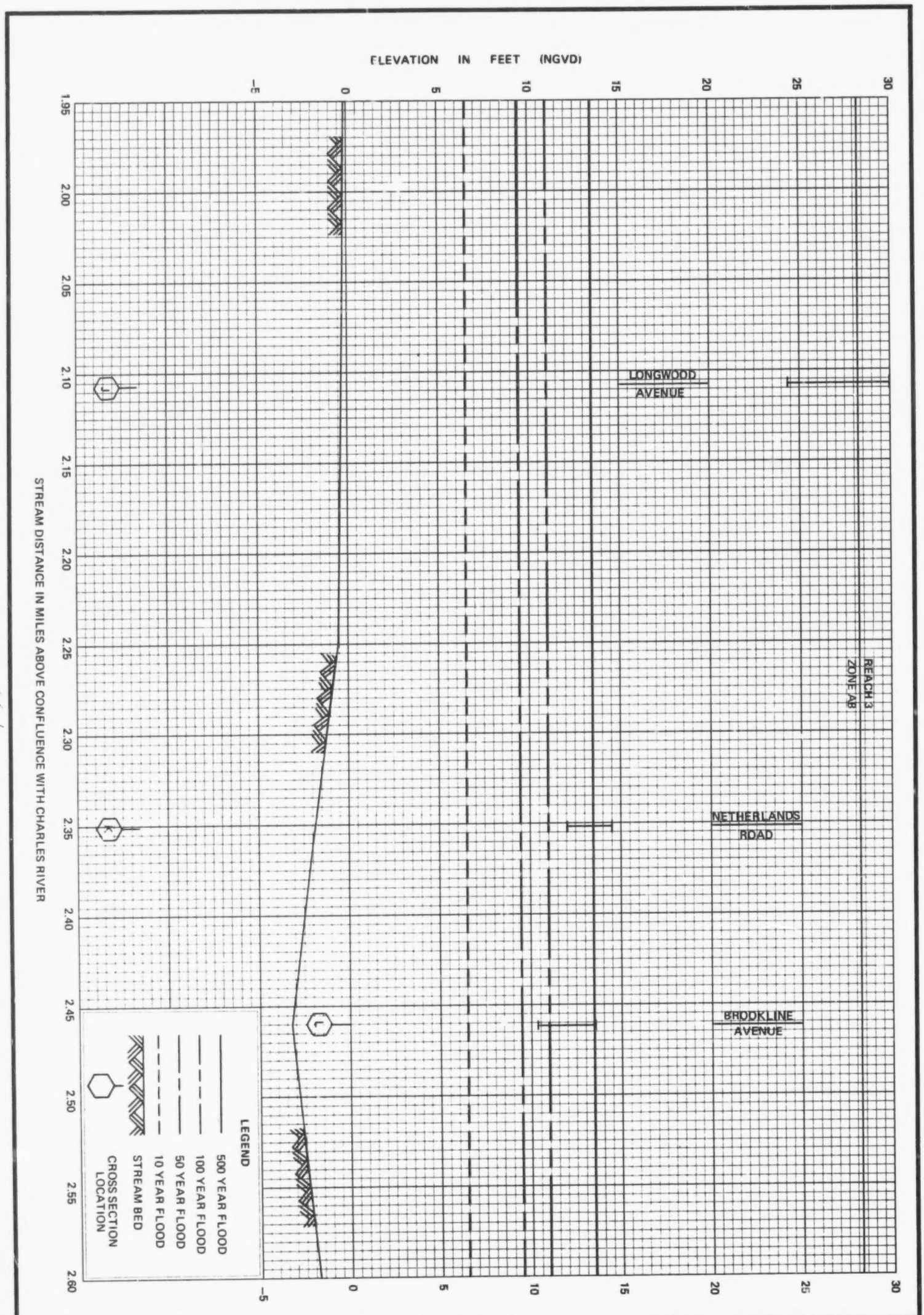
10P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

MUDDY RIVER



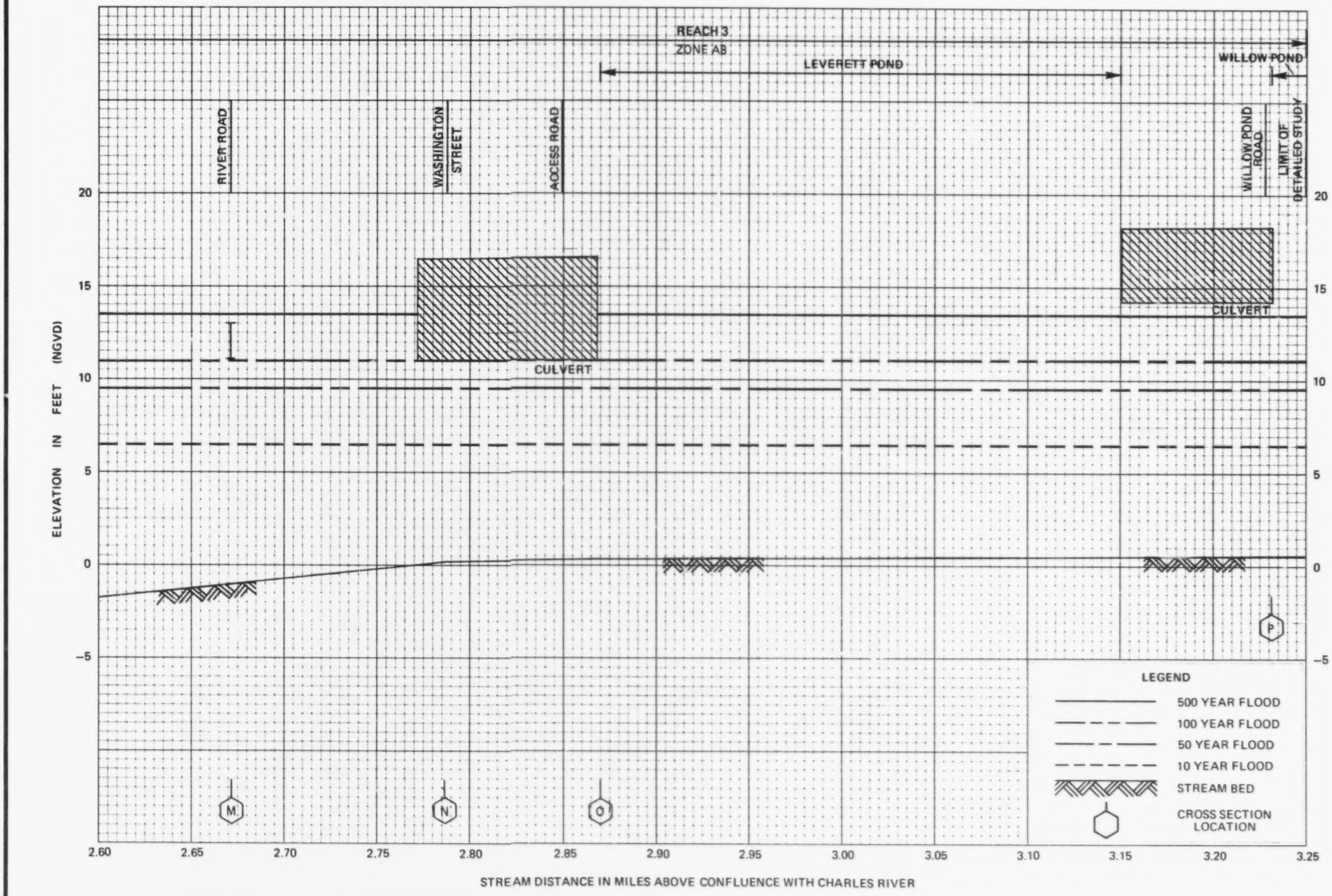
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

MUDDY RIVER

11P



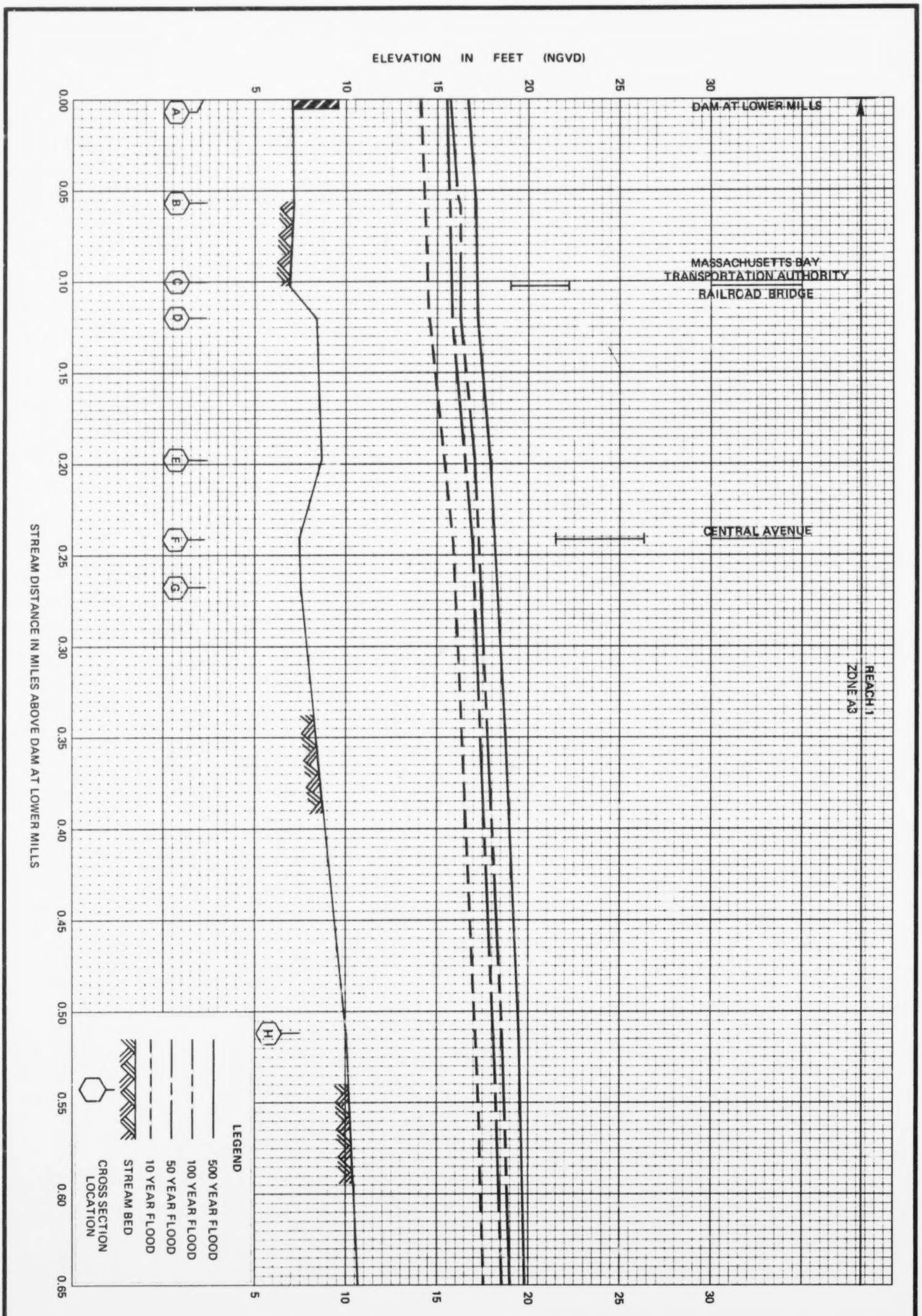
FLOOD PROFILES

MUDDY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

12P



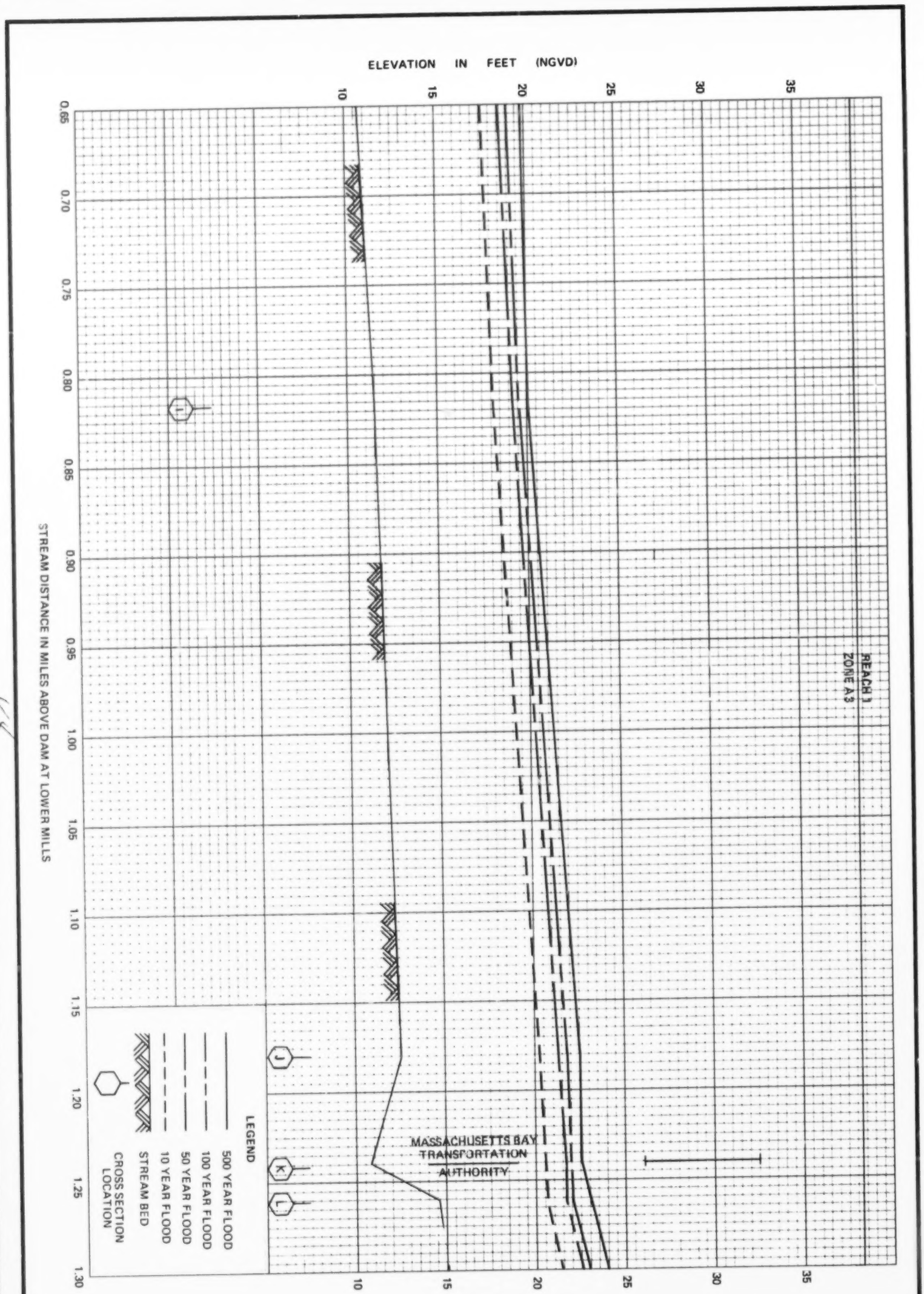
13P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER



14P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER

REACH 1
ZONE A3

ELEVATION IN FEET (NGVD)

45
40
35
30
25
20
15

BLUEHILL PARKWAY

M
N
O
P

LEGEND
- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

1.30 1.35 1.40 1.45 1.50 1.55 1.60 1.65 1.70 1.75 1.80 1.85 1.90 1.95

STREAM DISTANCE IN MILES ABOVE DAM AT LOWER MILLS

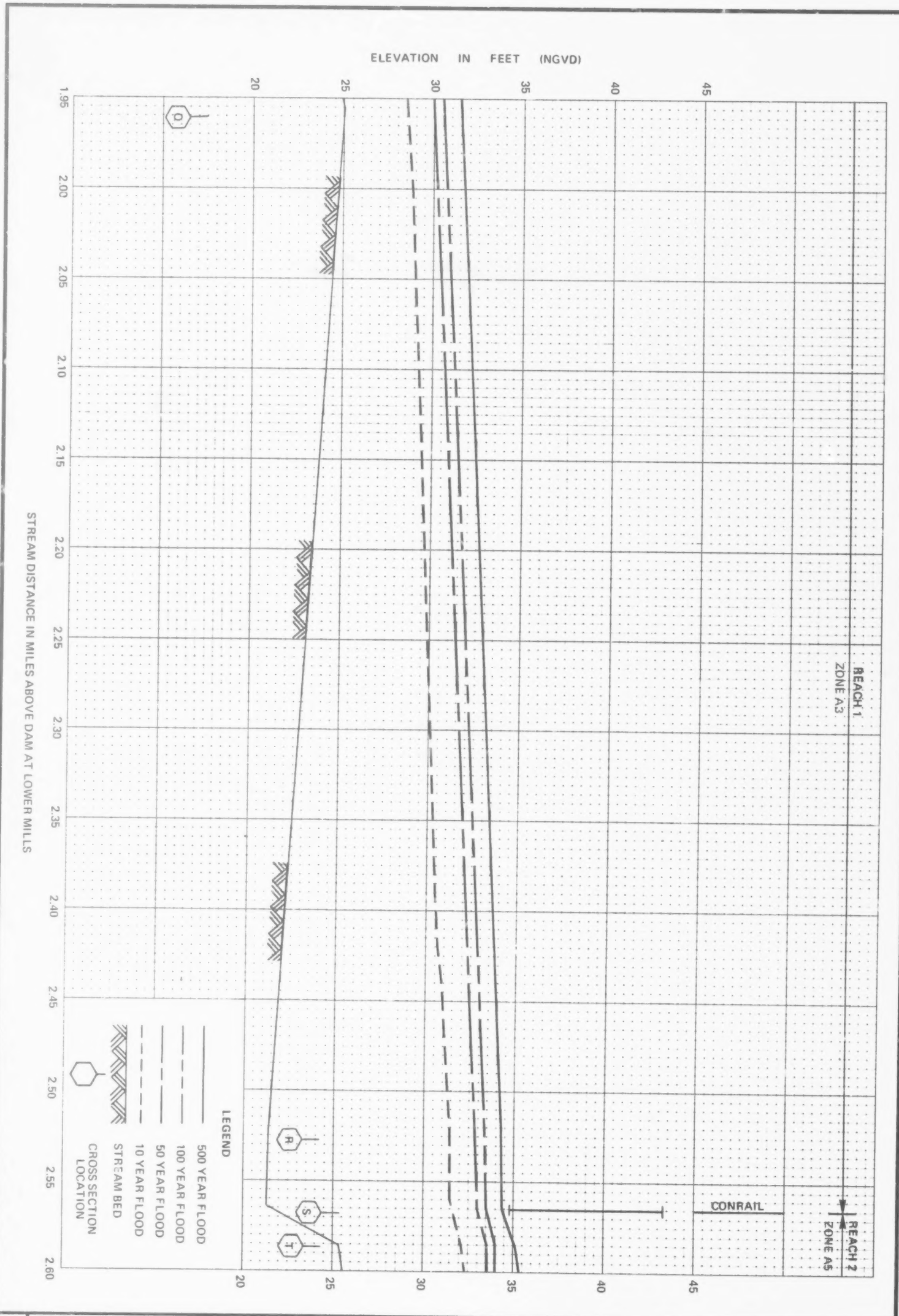
FLOOD PROFILES

NEPONSET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

15P



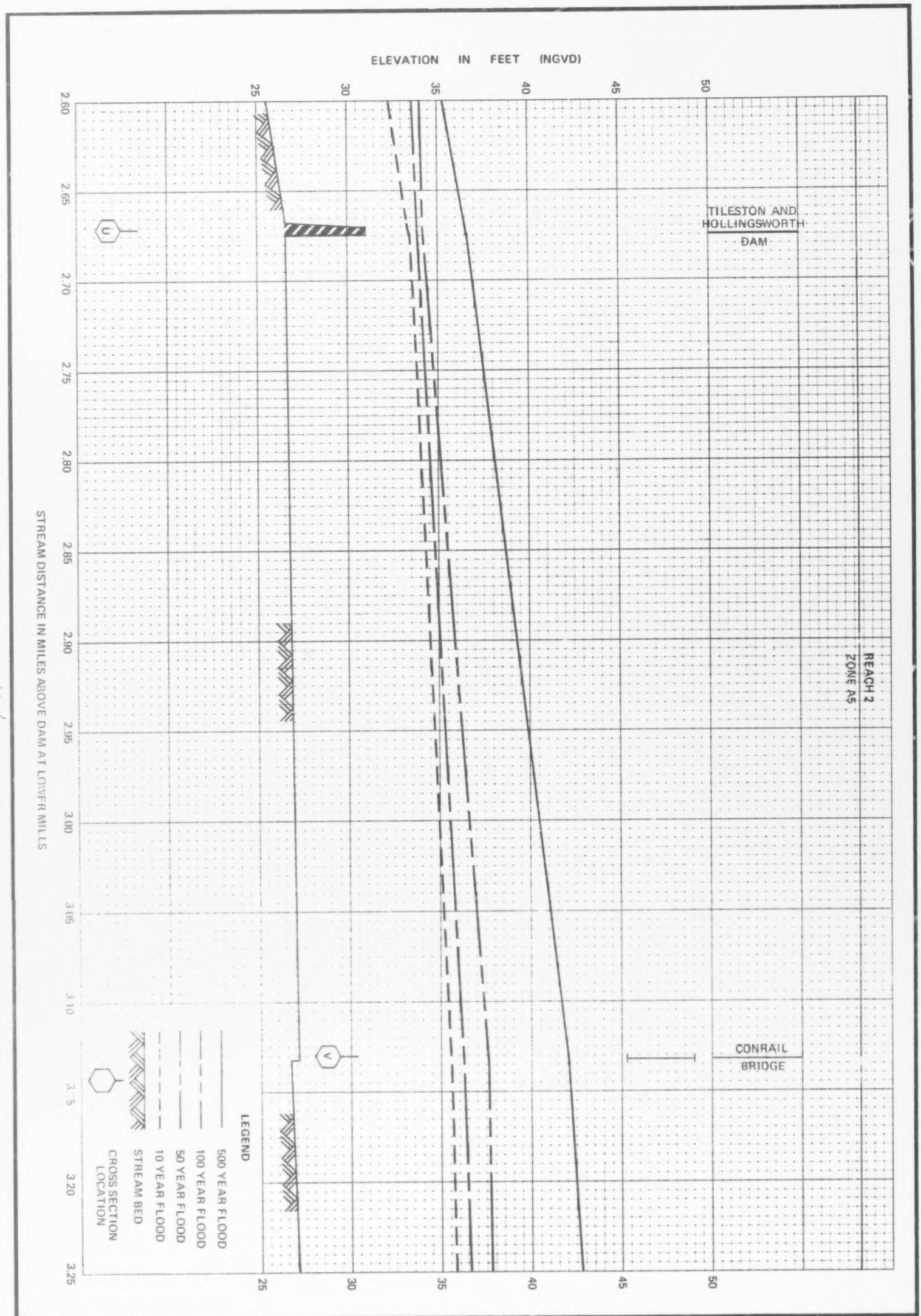
16P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER



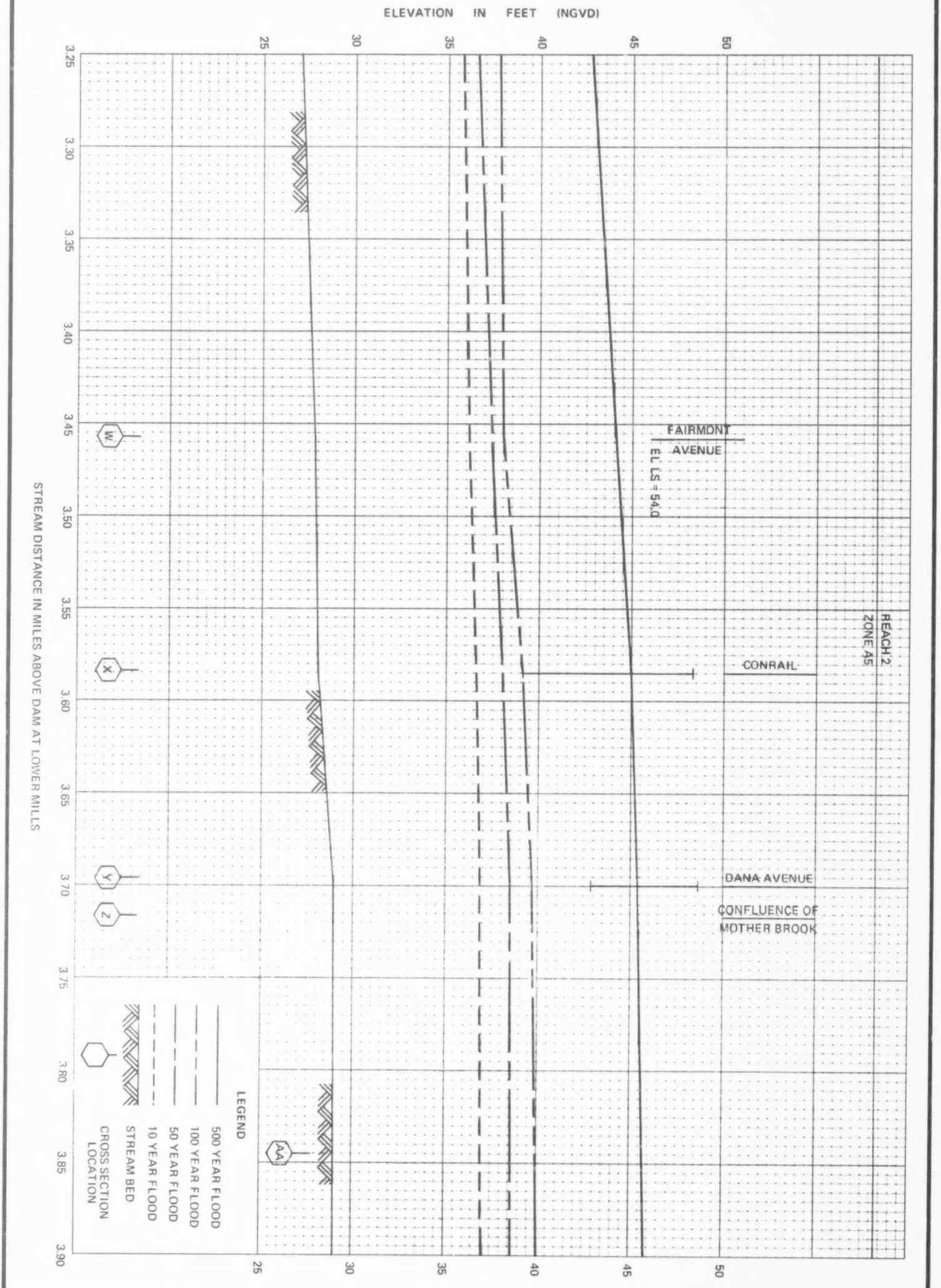
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER

17P



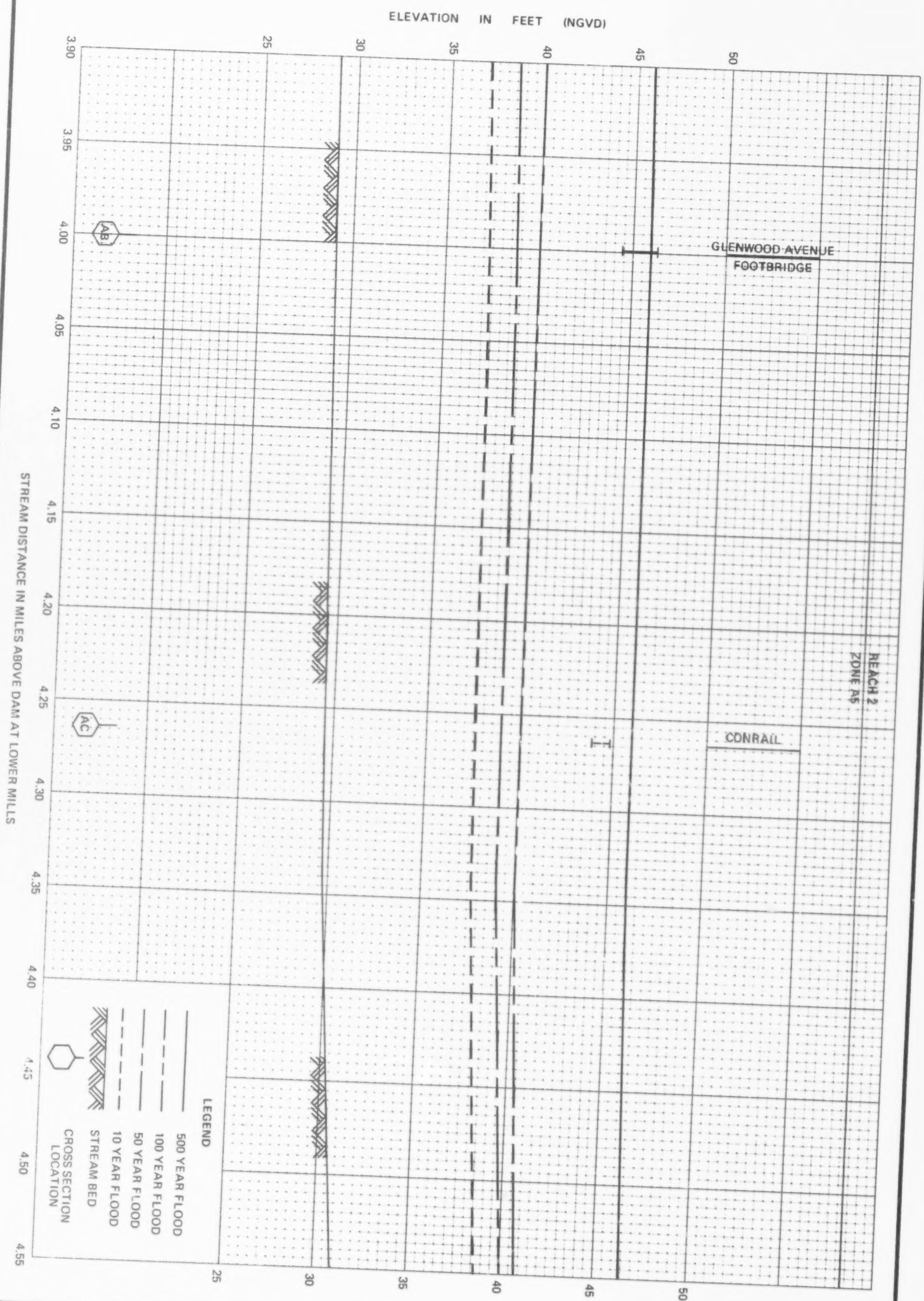
18P

FEDERAL EMERGENCY MANAGEMENT AGENCY

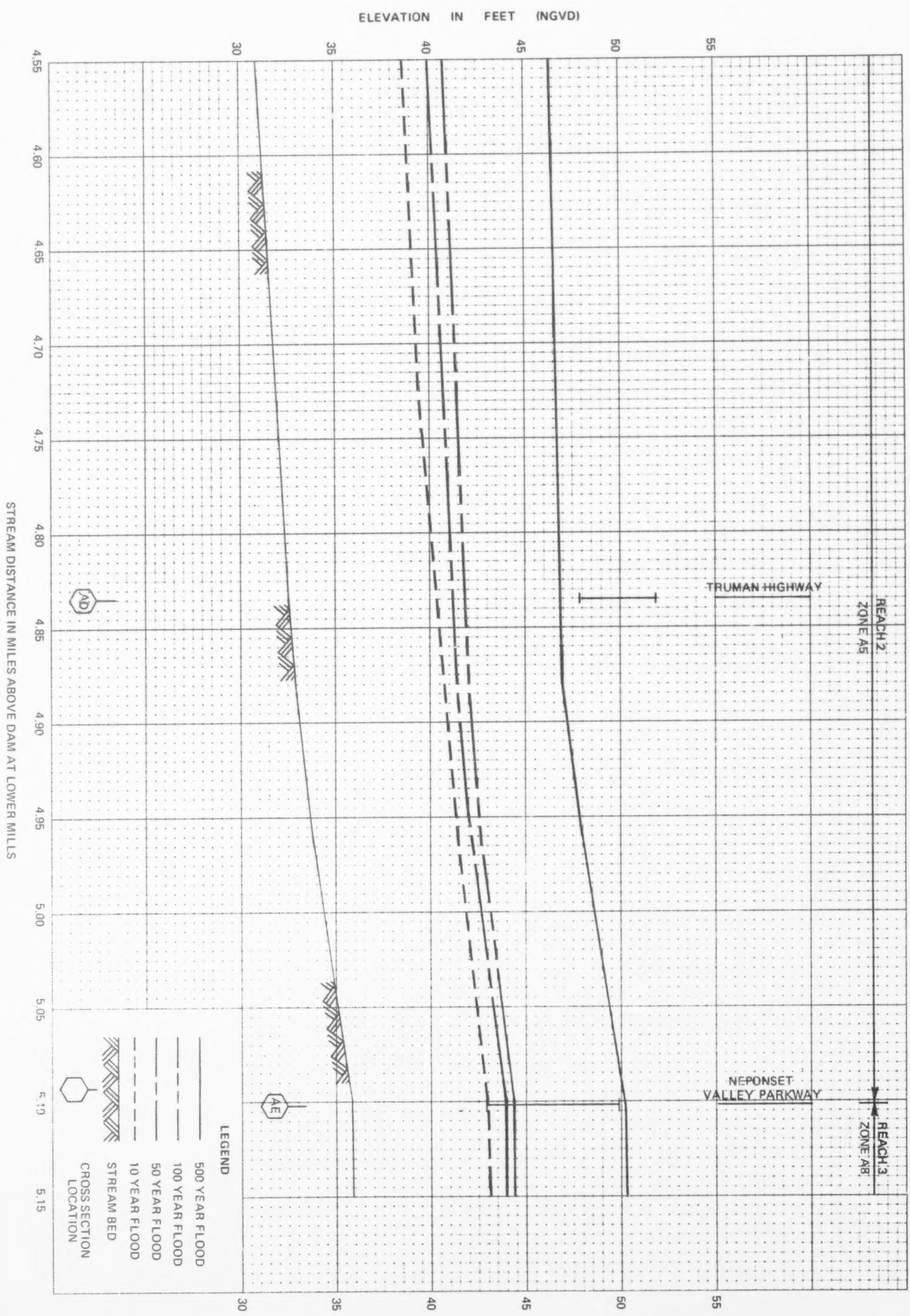
CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER



19P	FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOOD PROFILES
	CITY OF BOSTON, MA (SUFFOLK CO.)	NEPONSET RIVER



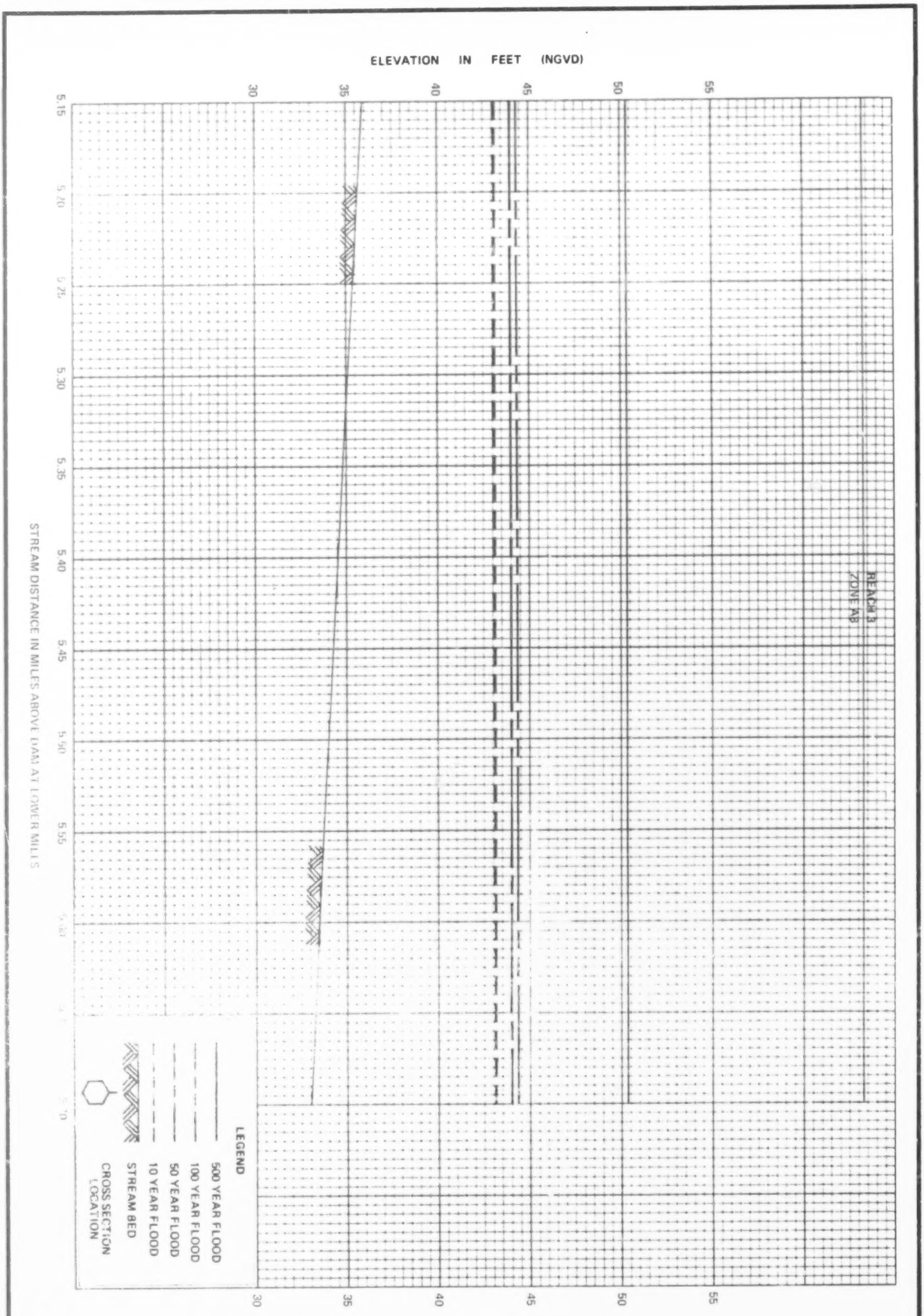
20P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER



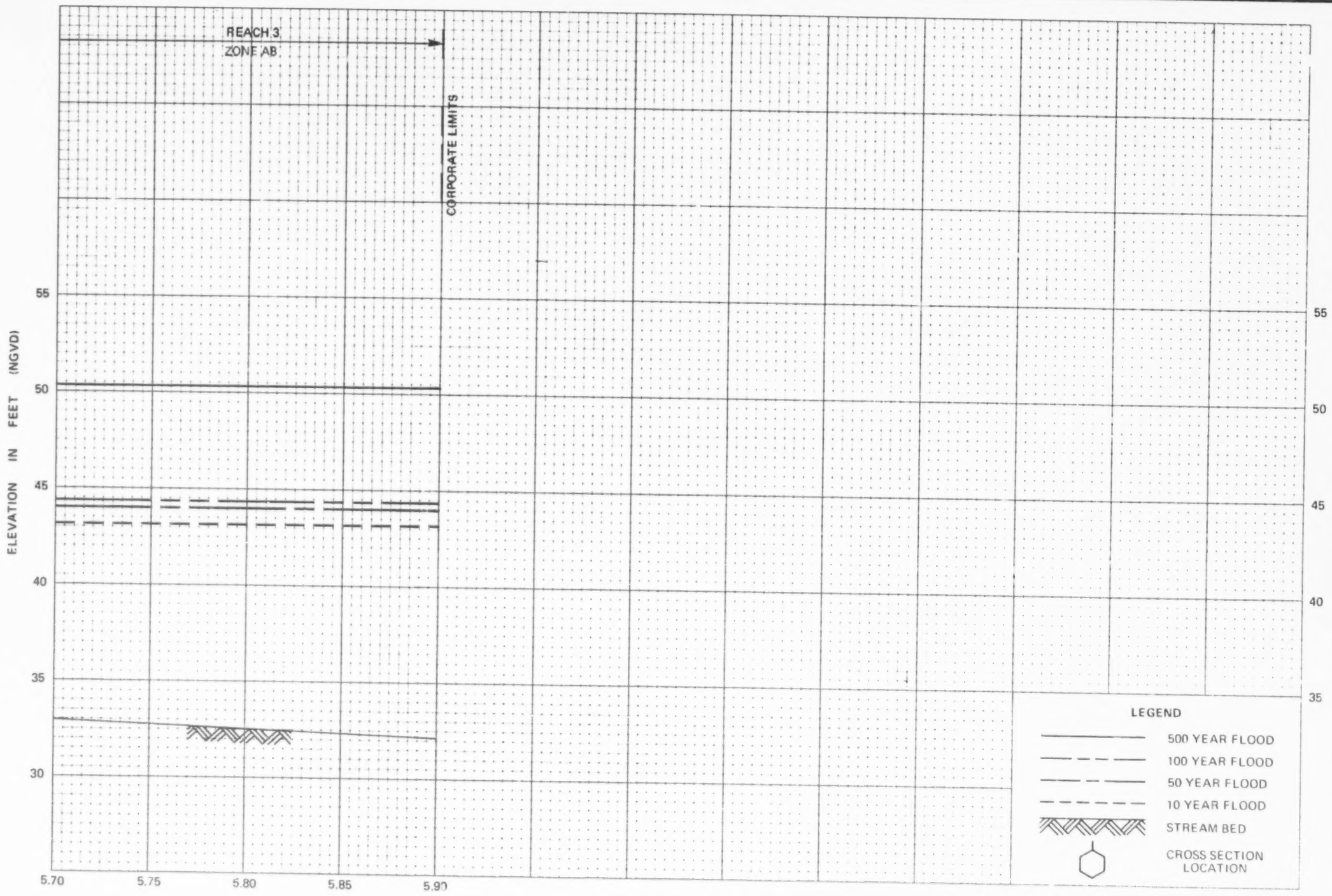
FEDERAL EMERGENCY MANAGEMENT AGENCY

21P

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

NEPONSET RIVER



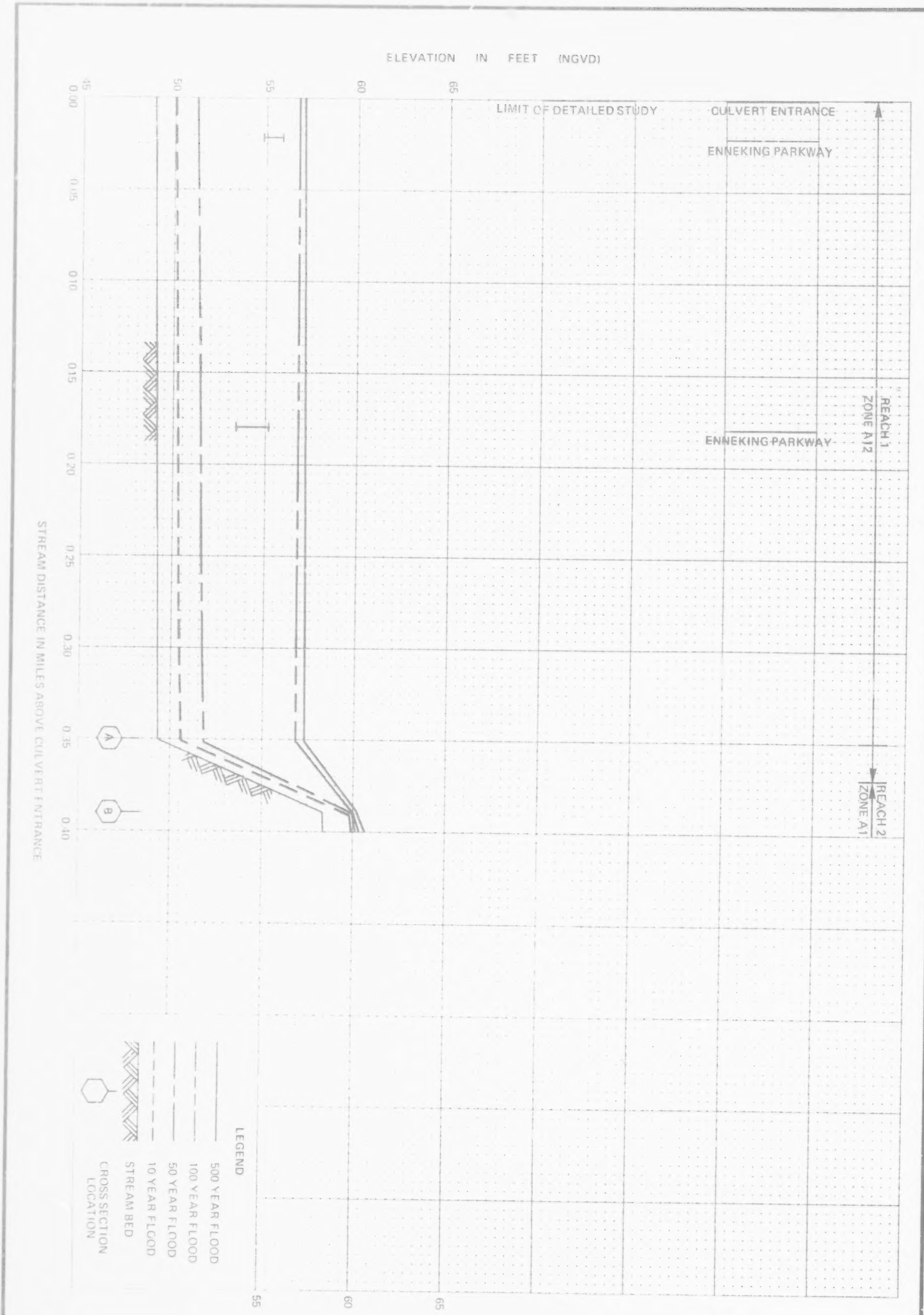
FLOOD PROFILES

NEPONSET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

22P



23P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF BOSTON, MA (SUFFOLK CO.)	FLOOD PROFILES STONY BROOK

REACH 2
ZONE A1

ACCESS ROAD

ELEVATION IN FEET (NGVD)

100
95
90
85
80
75
70
65
60
55

0.40 0.42 0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58 0.60 0.62

STREAM DISTANCE IN MILES ABOVE CULVERT ENTRANCE

C D E

LEGEND

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

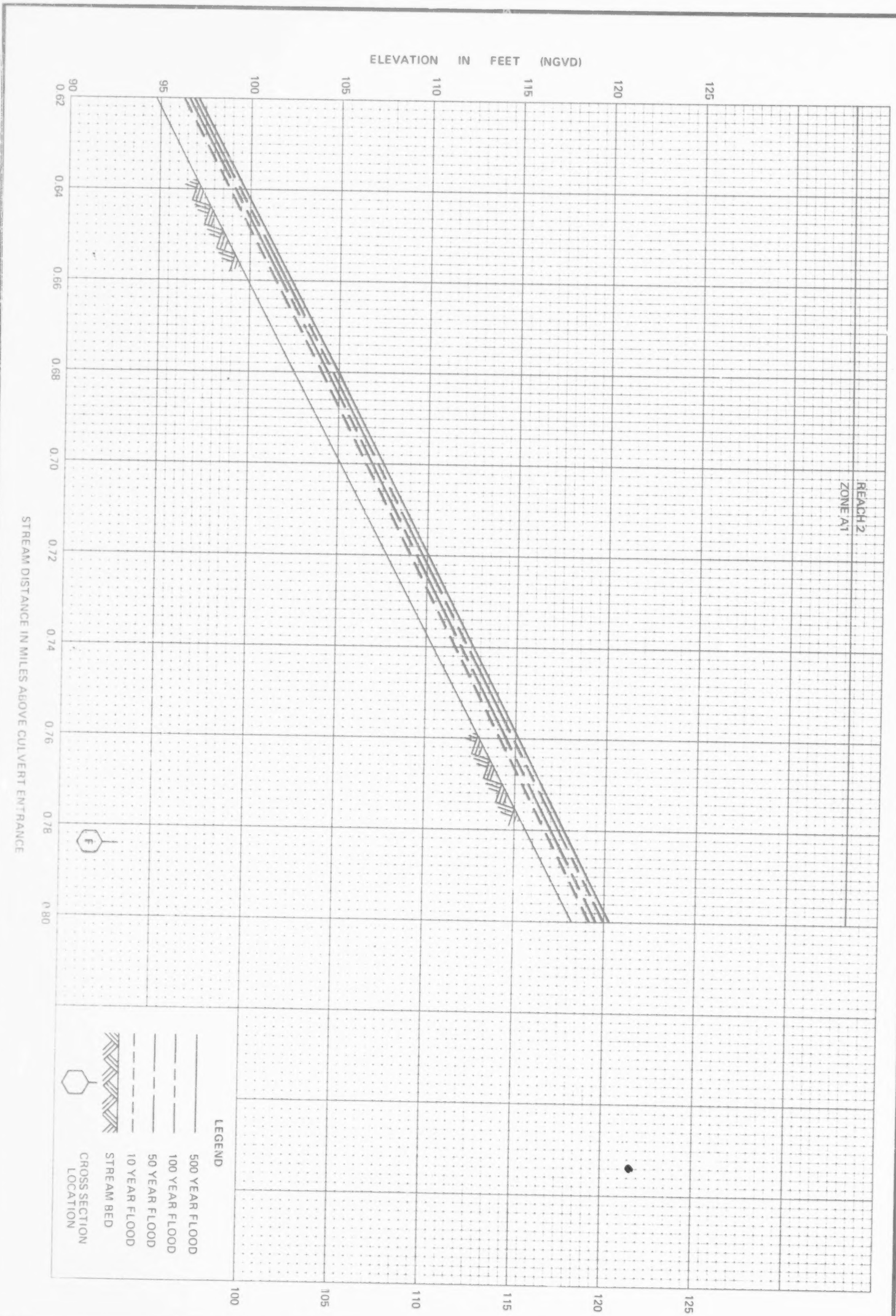
FLOOD PROFILES

STONY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

24P



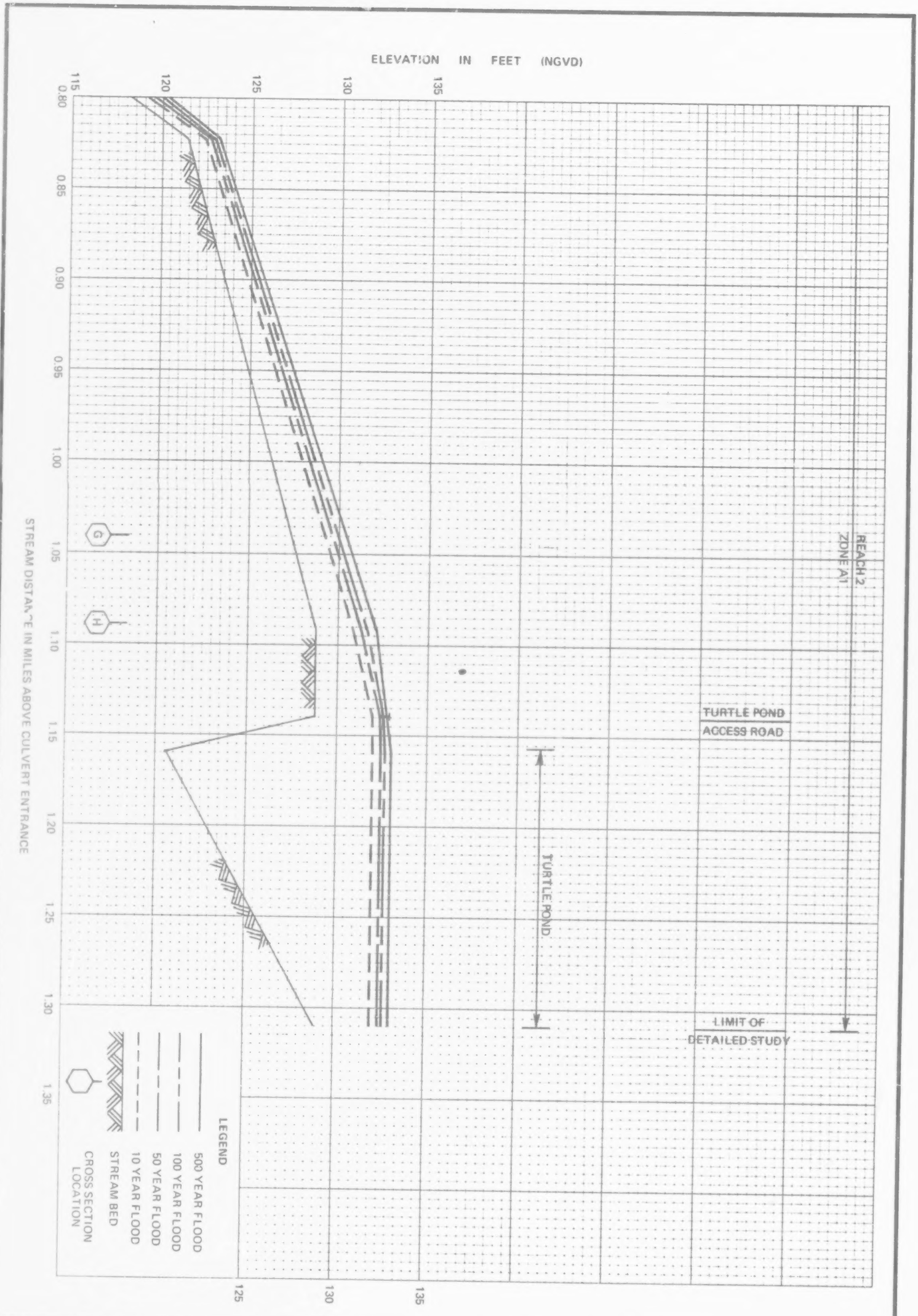
25P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BOSTON, MA
(SUFFOLK CO.)

FLOOD PROFILES

STONY BROOK



26P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF BOSTON, MA (SUFFOLK CO.)	FLOOD PROFILES STONY BROOK